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GLACIAL EROSION IN ALASKA[1]

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WHEN Henry Gannett made the statement that "thousands of cubic miles" of rock had been removed from the fiords of southeastern Alaska by glacial erosion, and that "the relief features of this region, its mountains and its gorges partly filled by the sea, are all of glacial origin,"[2] it is probable that many readers had the feeling that he had greatly exaggerated the case of glacial erosion. For my own part, I distinctly remember reading this with the feeling that, although glaciers are unquestionably capable of doing great work of erosion, it would require the most convincing evidence to satisfy me of even the approximate accuracy of this statement. Having now made four trips over a part of the route upon which Mr. Gannett based his statements, and having examined the phenomena attentively, there and elsewhere, I have the conviction that in reality his statement of the case is in close harmony with the truth. It is the purpose of this paper to state the argument upon which this conclusion is based.

It is a well-known fact that it is possible to go from Seattle to Sitka, along a series of 'Channels,' 'Canals' and 'Reaches' without once entering the open ocean. In addition to this unique 'Inside Passage' of upwards of 1,000 miles, there is a maze of branches of such enormous extent that the whole system of channels has not yet been charted. Everywhere these arms of the sea are enclosed between

[1] Published by permission of the Director of the U. S. Geological Survey. I am indebted to Lawrence Martin and O. von Engeln, members of my expeditions, for photographic work, as indicated under the illustrations, and to Mr. Martin and B. S. Butler for valuable assistance in my field investigations.

[2] Harriman Alaska Expedition, Vol. II., History, Geography, Resources, 1902, pp. 258–259.

FIG. 1. ALIGNED SPURS, INSIDE PASSAGE. Three such spurs seen on the right, the most distant one showing the change in slope. Two shown on the left, with the change in slope plainly visible in the more distant one. From such a condition as this there is every gradation to straight walled 'canals' Photograph by O. von Engeln.

mountain walls, and in many places they have the characteristics of grand fiords.

Such a topography as this has, until recently, been quite generally explained as a result of subsidence of the land, by which the lower ends of the land valleys have been drowned by the admission of the sea water into them. In this way the irregular coast of Patagonia, the fiords of Norway, and other similar coast lines have been explained.

Under ordinary conditions, the development of valleys by stream erosion produces certain characteristic features which are easily recognizable. These features are well understood by physiographers and have been fully stated on many occasions, and especially by Professor Davis, to whom, more than to any other, we owe our clear recognition of them and their application to the problems of glacial erosion.

One of these features is the cross-section of the valley, which varies in width and steepness according to the stage of its development. A young stream valley is steep-sided and gorge-like. Its width is narrow in proportion to its depth. A mature valley, having long been exposed to action of the weather, has been broadened out by the weathering back of the valley walls so that its width is great as compared with its

depth. For a stream valley to pass from youth to maturity, even under the most favorable conditions, requires a great lapse of time.

The form of river valley to be expected in such a mountainous country as the coast of British Columbia and Alaska, would therefore depend largely upon the length of time that the streams had been working to cut the valleys. Had the stream action been brief, we should expect to find profound gorges; had it been long, broader valleys and the more gentle slopes of maturity. If, as is the case in Alaska, the same valleys have some of the characteristics of youth and some of maturity, a special explanation must be sought.

A second characteristic which results from the normal development of stream valleys is the accordance in grade between main and tributary streams. No matter how fast the main stream may be lowering its valley, even though it be a Colorado River, the side streams, including even weak tributaries, lower their mouths at approximately the same rate that the main stream deepens its valley. This feature is so well established as a normal condition of valley development, that it may be stated as a law that, under normal conditions of stream development, tributary valleys enter main valleys approximately at grade. That this is not the case in many instances in Alaska will be shown below.

A third feature normally developed during the formation of stream valleys is that of a somewhat winding course with overlapping spurs, alternating first on one side then on the other. Because of this

FIG. 2. LARGE TRIBUTARY VALLEY ENTERING GRENVILLE CHANNEL FROM THE EAST, BELOW THE SEA LEVEL. Note steepened lower slope on left side of tributary valley. Photograph by Lawrence Martin.

FIG. 3. HANGING VALLEY IN GRENVILLE CHANNEL, INSIDE PASSAGE. Waterfall of stream draining the broad, U-shaped valley seen near water in right-hand half of picture. Photograph by Lawrence Martin.

feature a view up or down such a valley is not usually very extensive, being cut off by the projecting spurs around which the stream swings. The absence of this feature in those Alaskan valleys where there is a

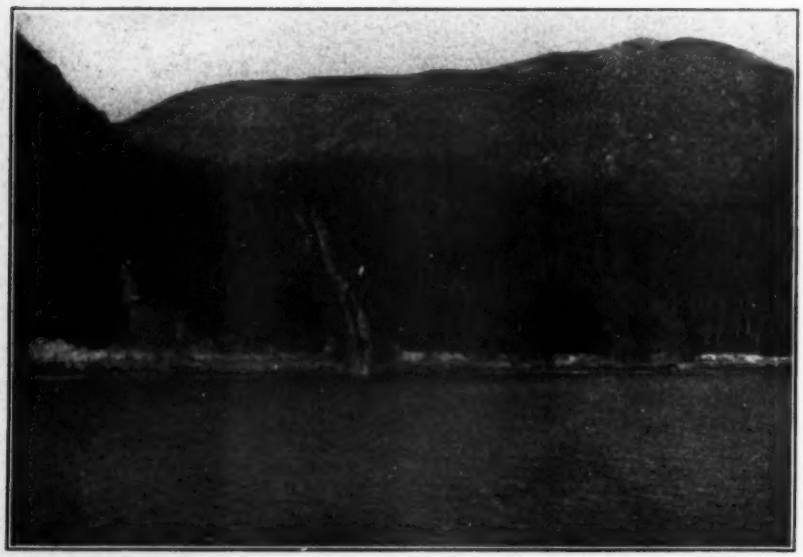

FIG. 4. WATERFALL ON THE VERY FACE OF THE ROCK LIP OF A HANGING VALLEY BEHIND SARA ISLAND, INSIDE PASSAGE. Photograph by Lawrence Martin.

discordance in the other directions mentioned above, calls for explanation.

The partial submergence of a region traversed by a series of valleys with the characteristics just stated, would produce results which can be readily and accurately predicted. The line up to which the new sea level reached would be rendered irregular for two reasons. In the first place, the overlapping spurs would introduce a winding coast line in the fiords, with capes on one side opposite reentrants on the other. In the second place, since the tributary valleys joined the main valleys at grade, the sea water would enter their mouths and thus transform their lower portions to bays.

Examining the actual conditions along the Inside Passage to Alaska, we find very wide departures from this postulated result of a drowning of normal land valleys. Many of the passages are in the form of long straight 'Reaches' and 'Canals,' up and down which one can look for miles without obstruction to the view. In other cases the 'Reaches,' though not perfectly straight, have alternating projections and reentrants (Fig. 1). These, however, depart from typical overlapping spurs in two important respects. In the first place, they are much less pronounced. In the second place, instead of having a uniform slope from the crest to the tip of the spurs, they have a moderate slope above, like that of ordinary valley spurs, but terminate on the water side in a steep and even precipitous slope. They have the appearance, therefore, of being *truncated* valley spurs; and a view through such a channel often shows a succession of these partial spurs with the truncated faces in alignment. The general appearance of these aligned spurs suggests that some powerful rasping agent has moved through the fiord and truncated the overlapping spurs back to a fairly uniform distance.

The fiords of the Inside Passage furnish all gradations from typical overlapping spurs to aligned spurs, and to straight, smoothed 'Canals' from which all semblance of spurs has been erased. In the latter case the valley walls themselves often possess a double slope, steep and even precipitous below, more gentle above. The steepened lower slope has the appearance of having been incised in a valley whose remnant is represented by the upper more gentle slope.

In those 'Reaches' which are long and straight, and in those with aligned spurs, the tributary valleys enter the main valley at very different levels. Some, especially the larger, enter below the level of the sea, and in these cases there are bays in their mouths (Fig. 2); many others have their mouths high above the fiord level (Figs. 3, 4 and 5). Although there is no uniform height at which these side valleys enter the main trough, in general it is true that, the smaller the tributary valley, the higher its mouth lies above the main valley bottom. These are called *hanging valleys* because their mouths hang above the bottom

FIG. 5. HANGING VALLEY, GRENVILLE CHANNEL, INSIDE PASSAGE. The forest-covered lip is solid rock, but it looks like a dam. Doubtless if one went to the crest of this lip he would find the broad valley extending, with moderate grade up the distant mountain. Note the waterfall near center of picture. Photograph by Lawrence Martin.

of the main valley to which they are tributary, instead of entering at grade, as is normal.

Where these Alaskan hanging valleys are most typically developed, the appearance is quite remarkable. The valley wall of the long, straight 'Reach' or 'Canal' is broken by a broad U-shaped tributary valley, whose cross section, if explained by ordinary methods of valley formation, would require a long period of time for its formation. The stream occupying the hanging valley flows with moderate grade up to the point where the tributary valley is intersected by the straight wall of the main 'Reach.' Then, instead of continuing into the main valley with the same grade, it tumbles over the lip of the hanging valley and descends to the fiord in a succession of leaps, sometimes on the very face of the main valley wall (Fig. 4), sometimes in a shallow gorge (Figs. 3 and 5).

In these most typical cases, there is such an absolute discordance of conditions as to cause comment from even the most casual observers, as I had occasion to observe in many instances in sailing through the Inside Passage. The first feature to attract attention was the waterfall. It was then noticed that the stream emerged from a broad valley, far up which one could look, though without seeing its bottom (Figs. 3–5). This produced the impression that the lip of the hanging valley was really a dam across the mouth of a broad tributary valley.

This deceptive appearance was so striking that, on asking fellow voyagers for an explanation of the hanging valleys, I have again and again received the answer that the mouth of the valley has been dammed and a lake formed behind it. So apparent is this explanation that the captain of the steamer stated positively that there are always lakes behind these lips.

Thus the hanging valley is so abnormal a feature that even to ordinary observers it seems to demand some special explanation. That there are lakes in some of the hanging valleys is probable; but it is not a necessary condition. The lip is not a dam; it is unconsumed rock in a valley bottom that has been left high above the main valley by exceptional conditions which have deepened the main trough. It was of course impossible to stop and go into the many hanging valleys which we passed in the Inside Passage, but farther up the coast I was able to enter such valleys and prove, what I was well aware of before, that the lip is not a dam and that lakes form no necessary part of the hanging-valley condition (see Figs. 7 and 8).

Two other features of the valleys in the Inside Passage are noteworthy. One is the fact that in both the main and tributary valleys the rock walls have been smoothed and rounded by glacial action, proving the former extension of glaciers through this series of 'Reaches.' The other is the remarkably uniform cross-section of both the main and tributary valleys, as is so well illustrated in many of the accompany-

FIG. 6. A HANGING VALLEY ON THE SOUTH SIDE OF NUNATAK FIORD. This valley lies on the same side, but about a mile west of the succeeding pictures (Figs. 7, 8 and 9). The floating ice is from Nunatak glacier about four miles distant. Photograph by Lawrence Martin.

ing photographs. They are distinctly U-shaped with smooth and regular walls. In spite of their breadth, which is a normal characteristic of mature valleys, the enclosing walls, especially in the lower portions, are oftentimes exceedingly steep and even precipitous, a characteristic of young, not of mature, stream valleys. Thus the same valley has the characteristics of two stages of development, the breadth of maturity and the steep-sidedness of youth.

It is evident that such conditions as those which characterize so many of the valleys of the Inside Passage can not be due to normal conditions of stream valley development. The discrepancies and anomalies are altogether too numerous and striking for such an explanation.

FIG. 7. THE ROCK LIP OF A HANGING VALLEY JUST WEST OF THE NUNATAK IN NUNATAK FIORD. There is a vertical difference of 700 feet between the camera site and the lip of the valley. Photographs 9 and 10 were taken from this lip. Photograph by O. von Engeln.

If this is true of the origin of the valley forms, it follows that the present outline of the intricate maze of channels on this coast cannot be explained as a result of the drowning of normal stream-made valleys, as has been so universally believed to be the case.

It is now quite generally admitted that some of the features which characterize the 'Reaches' of the Inside Passage do not admit of explanation as a result of normal stream work. The feature that has been most uniformly admitted to be abnormal is that of discordance of tributary and main valleys. The explanation of this hanging valley condition as a result of glacial erosion, which this paper is supporting, is not, however, so uniformly accepted; the chief objection of those who have not yet accepted it being their belief that glaciers are incompetent to perform such great work as would be required if hanging valleys are

explained in this way. In consequence of this inability to accept the conclusion that glaciers are powerful agents of erosion, a number of alternate hypotheses have been suggested, of which the following are some of the most prominent.

One of these special explanations is based upon the conception that glaciers act to *protect* rather than to erode. This explanation assumes that glaciers occupied and protected the tributary valleys while the main valleys were free from ice, and that, while this condition lasted, the main valleys were so deepened that, when the ice finally melted from the protected tributary valleys, they were hanging well above the overdeepened main troughs. When it is considered that thousands of hanging valleys are already known, and that in each case it was necessary for a small glacier to linger with its terminus at the very lip

FIG. 8. LOOKING INTO HANGING VALLEY (FIG. 7) FROM ROCK LIP AT ELEVATION OF 700 FEET. The stream flows in a small gorge at the right. The elevation in the middle background of the valley is the moraine-covered terminus of a dwindling glacier. The valley floor is all rock, and rock extends continuously across its mouth. Photograph by O. von Engeln.

of the hanging valley throughout the long period of time required to deepen the main channel, this explanation seems almost too absurd to consider. It furthermore fails to account for the aligned spurs, and, above all, for the great breadth and U-shape of the main troughs. While one might admit this as a possible cause for individual cases, it fails utterly as a general explanation.

A second hypothesis proposed, is that glacial erosion is lateral rather than vertical, and that the hanging valleys are due to the wearing back of the tributary mouths so that they are left hanging. That

FIG. 9. FROM SAME SITE AS FIG. 8, LOOKING OUT INTO THE MAIN TROUGH OF NUNATAK FIORD TO WHICH THE VALLEY (FIGS. 7 AND 8) IS TRIBUTARY. Gorge cut in rock lip on left, bottom being just out of sight. Walls of gorge is rock, like rest of lip. Elevation 700 feet; depth of fiord unknown; but large icebergs float freely in it. Photograph by O. von Engeln.

there is marked lateral erosion is generally admitted by all believers in glacial erosion; but that this is the dominant form of glacial erosion would require for its acceptance much better evidence than has been presented. It may fairly be asked, if there is such pronounced lateral erosion, why should there not also be vertical erosion of equal or greater amount? Even if excessive lateral erosion should be granted as a possibility, of which there is no proof, it alone would fail to account for all the conditions observed. It would fail to explain why remnants of valley spurs are left side by side with pronounced hanging valleys; for in such cases the spurs should certainly be rubbed completely away. But, even more fatal than this is the fact that if the grade of the hanging valley is projected out into the main valley, it will, in a vast number of cases, fall far short of meeting the main valley at grade. Consequently, if glacial erosion is admitted at all, the element of vertical erosion must be granted as a prominent part of the process.

A third explanation proposed for the hanging-valley condition is that of capture and diversion of tributary streams. No one would deny that the diversion of a stream by capture might leave it hanging above the valley to which it was originally tributary. But to attempt to apply such an explanation to the multitude of known cases of hanging valleys would not be so generally accepted. It would require a marvelous development of stream capture in special localities and, strangely enough, almost entirely in regions of former glaciation. Before this hypothesis could be seriously considered as a general explanation of hanging valleys, it would be necessary to account for the fact that this process has operated so extensively in glaciated regions, whereas it so rarely operates in unglaciated countries. But even if this explanation were otherwise probable for hanging valleys, it still leaves unexplained the associated phenomena of aligned spurs, steepened lower slopes and general U-shape of the main troughs.

A fourth hypothesis proposed is that of rejuvenation. By this it is assumed that the main and lateral valleys had an accordance of grade during an earlier cycle of development, but that recent uplift, or other cause, gave to the streams a new power of cutting, making them young again, or rejuvenating them. As a result of this there was rapid cutting, the main streams working much faster than the laterals and leaving them hanging. This explanation is totally inadequate for the Alaskan conditions. It fails to account for the truncated spurs; it gives no explanation of the difference in level at which the laterals are hanging; and, moreover, even if it operated, it could not possibly produce the other results observed. Such rejuvenation would not develop a broad main valley, but a narrow gorge. But, even if we were to admit, which physiographers would not, that such deepening and broadening of the main valley would be possible without corresponding deepening at the mouths of the laterals, it is inconceivable that, during

all the time required for the deepening and broadening of the main trough, the lateral stream was scarcely able to even scratch the lip of the hanging valley (Fig. 4). This point may be illustrated by a specific case, taken not from the Inside Passage, but from Nunatak Fiord, a branch of the Yakutat Bay Inlet which lies about midway between Sitka and Controller Bay just southeast of Mount St. Elias.

This fiord has been so recently occupied by ice that vegetation, excepting scattered annual plants, has not yet been able to take hold on the soil. The Nunatak Glacier (Fig. 14) has receded up this fiord more than a mile in ten years. Unquestionably there has been powerful glacial erosion here, for the walls of the fiord are smoothed and grooved by glacial grinding, and there are no valley spurs left. Several of the valleys tributary to the fiord are hanging high above it (Figs. 6

FIG. 10. LOOKING ACROSS THE MOUTH OF DISENCHANTMENT BAY, RUSSELL VALLEY (FIG. 11) ON LEFT. This valley is hanging at about sea level. A small valley to the right of this hangs fully 1,000 feet above sea level. A somewhat larger valley on the extreme right of the picture is hanging at a level intermediate between these two. To account for such discordance by faulting would demand very complex block faulting. But the rock walls of the fiord are plainly exposed and there is no evidence of it. Photograph by O. von Engeln.

and 7), and in all the larger of these small glaciers are still present. The entire absence of forest exposes the conditions here far more clearly than is the case along the forest-clothed Inside Passage.

Viewed from the fiord, the hanging valley selected for this illustration is plainly seen to be a broad, U-shaped trough heading well back in the mountains and with a small glacier at its head. The wide open mouth of this broad valley is truncated by the straight, steep rock wall of Nunatak Fiord and left perched high above even its water

surface. This valley wall extends completely across the mouth of the hanging valley, forming a rock lip seven hundred feet high (Fig. 7). Climbing to the crest of this lip, one is able to look up the hanging valley to its mountain-walled head (Fig 8). It is found to be a broad, U-shaped valley with a flat floor and moderate grade.

The ice-born stream which flows along the bottom of this valley has cut only a shallow trench in the rock floor, through which it flows with moderate grade until the lip of the hanging valley is reached, when its grade abruptly increases and it tumbles down the main valley wall, as a succession of waterfalls, in the bottom of a gorge so shallow that the entire series of cascades, from the crest of the lip to its bottom, is plainly visible from the fiord. The stream has *begun* to lower its grade to harmonize with the main valley; but it has not had time yet to carry the process very far. That there is no possibility of the presence of a drift-filled valley of earlier date is proved by the fact that bed rock outcrops across the entire lip.

On any assumption of stream rejuvenation, it is utterly incredible that all the time required to deepen the main trough of Nunatak Fiord, and to broaden it into the form of maturity which it possesses (Figs. 9 and 14), should have been too short to have permitted the stream in the hanging valley to cut a more profound gorge, on such a steep slope, and to attain a better approximation to that accordance of grades toward which all tributaries tend in their relation to the main streams. Wherever one critically examines a hanging valley in its relation to the main trough, the same conclusion is necessitated.

A fifth explanation that has been proposed is faulting. It is of course admitted that a block fault, by dropping down the bottom of a main valley, would leave the tributary valleys hanging. Although admitted as a possibility for individual cases, the application of such an explanation to Alaskan conditions in general, fails utterly to account for the facts. It would not explain the truncated spurs on both sides, nor the U-shape of the main and lateral valleys. Furthermore, without the introduction of complicated secondary faulting, it would not account for the difference in level at which the valleys hang above the main trough to which they are tributary (Fig. 10). Another fact which ordinary block faulting would fail to explain is the frequent presence of a condition of double hanging valleys,—a lateral hanging above the main valley, and a tributary of this lateral hanging above it.

Such a condition of double hanging valleys may be illustrated by the case of Russell Valley (Fig. 10) which enters the lower end of Disenchantment Bay, a part of the Yakutat Bay inlet. This valley has a moderate slope and a remarkably well-developed U-shape (Fig. 11). Where it joins the fiord it has built a gravel delta, so that there the actual rock bottom is not visible; but about a mile back from the fiord, bed rock occurs in the valley bottom near its center. Extending

FIG. 11. PHOTOGRAPH OF RUSSELL VALLEY WITH LONG FOCUS LENS FROM WEST SIDE OF DISENCHANTMENT BAY. Mouth of valley about three miles distant; length of valley up to glacier (where the snow line ends) about five miles. Note U-shape, steep, smoothed walls, absence of spurs, and flat floor. The hanging valley shown in Fig. 12 is the first upland valley on the left. Photograph by O. von Engeln.

the grade of this valley out into the main trough of Disenchantment Bay, where the nearest soundings show a depth of from 600 to 1,000 feet, the profile falls far short of reaching the bed of the bay. It is assumed, therefore, to be a hanging valley with the lip at or just below the surface of the fiord water. If we grant that this particular hanging valley may be due to faulting, which can not be disproved, we are still left with the necessity of assuming block faulting along the axis of the Russell Valley to account for the hanging condition of its own tributaries whose lips lie fully a thousand feet above the Russell Valley bottom (Fig. 12). In some cases even a third series of laterals have been seen hanging above a tributary, which itself hangs above another, which is hanging above a main trough.

To propose faulting as an explanation for such a complex system of hanging valleys does not seem rational without definite evidence of the faulting, and without some explanation of why the results of such recent faulting are so common in glaciated regions and so rare in unglaciated areas. Moreover, in some of the cases mentioned, for example, the Russell Valley itself, if there had been such faulting, it would be easily detected in the sedimentary rocks which form the walls of the valley. Since a search for evidence of recent faulting in this valley failed to find it, I feel warranted in asserting that there has been no such faulting as the theory demands. A glance at the photographs (Figs. 10 and 11) is sufficient to show that the form of this valley could not be accounted for on the basis of block faulting. Its flaring, curving, U-shaped sides are not the forms characteristic of cliffs due to faulting. Should it be stated that block faulting occurred at a date sufficiently remote to permit the weathering back of the valley walls to the present curve, it is sufficient to answer that in all the time required for this, the lateral streams must of necessity have trenched the bottoms of the hanging valleys and reduced them to an accordant grade with the Russell Valley stream. As Fig. 12 clearly shows, this is far from being the case.

From the above statement of hypotheses it will be seen that it is generally admitted that hanging valleys are a peculiar phenomenon calling for special explanation. It is also true that this phenomenon is practically confined to regions of former glaciation. Together with the U-shaped valley, truncated spurs, and steepened main valley slopes, the condition of hanging valleys is reported not only from a wide area in Alaska and British Columbia, but in such other regions of former glaciation as the Sierra Nevada, the Rocky Mountains, the Finger Lake Valleys of central New York, the coast of Norway, the Alps, the Himalayas and New Zealand. While exceptional instances of hanging valleys, which are readily explained in other ways, have been reported from unglaciated regions, these are so few and scattered, and

FIG. 12. HANGING VALLEY TRIBUTARY TO RUSSELL VALLEY (FIG. 11). The first tributary from the mouth on the north side. The lip of this valley lies about 1,000 feet above the main valley floor, and the stream flows over it on the very surface of the rock, forming a gorge, below which it crosses moraine. A small glacier lies at the head of this hanging valley. Photograph by Lawrence Martin.

so unlike their abundant and striking development in glaciated regions, that they are hardly to be considered as bearing upon the problem.

The facts discovered in reading the literature and in field investigation, point to glacial erosion as the cause of the hanging valleys and associated phenomena, while no facts are found that are vitally opposed to it. Of no other hypothesis proposed may the same be said; on the contrary, all other explanations are open to fatal objections. The great majority of students of glacial action are now in accord with the belief in profound glacial erosion in favorable situations. Even those opposed to the explanation by glacial erosion admit that the forms under discussion are what would be *expected* if it were possible for glaciers to perform such great erosive work.

The few who are opposed to this explanation have been able to offer no better argument against it than their failure to believe in the ability of ice to do erosive work in great amount. Some of this opposition is based upon observations at the margins of small glaciers. But all such observations have little value; for, as has been well stated by another, if an observer could have been where ice was really capable of profoundly eroding, he would not have been able to come back and talk about it. The weak, retreating margin of a small valley glacier gives no better basis for understanding profound glacial erosion than a small meadow brook gives for a conception of the mode of formation

of a Colorado Canyon. The objections to ice as an agent of profound erosion remind one very much of the objections which, in the early days, were urged against water as an agent of erosion. In this connection reference may be made to a short note, signed H. G., on page 249 of the *National Geographic Magazine,* Vol. 16, 1905. This little squib, which we may fairly safely ascribe to Henry Gannett, although written in a humorous and somewhat sarcastic vein, is really a noteworthy contribution to the discussion on glacial erosion. In it, as a sort of reply to a recent arraignment of glacial erosion, he applies to the now accepted belief in river erosion some of the same class of arguments as those which have been urged against glacial erosion, and with telling effect.

Since the establishment of the theory of profound glacial erosion is the work of the last fifteen years, and since the full force of the evidence has only recently been accepted by some of our leading physiographers, it is natural that as yet there should not be universal acceptance of so new an idea, carrying with it such tremendous consequences. But the fact that some workers have not yet accepted the doctrine does not necessarily constitute a strong argument against it, and certainly not enough to counterbalance the overwhelming evidence in its favor. When a large number of people are involved, ultraconservatism is always to be expected among some of them. There are, for example, even at the present day, some highly intelligent men who are writing

FIG. 13. THE NORTH WALL OF HIDDEN GLACIER VALLEY, A TRIBUTARY TO THE YAKUTAT BAY INLET, THE GLACIER TERMINUS SHOWING IN THE MIDGROUND. Note the smoothed, striated lower walls due to glacial erosion as contrasted with the irregular topography of the higher slopes due to ordinary weathering and stream erosion. A hanging valley enters at about the level between these two classes of slopes about a third of the way from the right margin above the glacier. Photograph by R. S. Tarr.

polemics in opposition to the belief in former continental glaciation, which almost every one now considers definitely established, though after a hard fight.

It does not seem necessary at the present time to undertake to show *how* the glaciers did this, nor to prove that they *could* do it when the evidence is so clear that they actually *did* do it. Suffice it to say, that if glaciers smooth, scratch and pluck the rocks over which they pass, as every one knows they do (Fig. 13), it requires only a sufficiently long continuation of this action to lower valleys to any extent up to the time when they cease to further smooth, scratch and pluck. A century ago it seemed to many observers that at the slow observed rate of recession of Niagara Falls it was impossible to explain

FIG. 14. LOOKING UP (EAST) NUNATAK FIORD. The rock knoll, or Nunatak, in the middle of the picture, 1,400 feet high, splits the Nunatak glacier, one arm, on the left, descending to the sea through the broader valley, the other occupying a smaller U-shaped valley on the right side of the Nunatak, but not upon reaching the sea. When first seen by Prof. Russell in 1891 these two arms nearly enclosed the Nunatak. The site of the hanging (Fig. 7) valley is on the right side of the picture. Photograph by Lawrence Martin.

the seven miles of gorge as a result of this process. No one now doubts this explanation of the Niagara gorge; and it is not doubted that the Colorado Canyon has been formed by slow sawing into the strata, like that which the river is now engaged in, but continued through a long period of time. An application of the same principle—a slow rate of erosion working for a long period of time—is all that is necessary to understand profound glacial erosion, once it is granted that glaciers

do scour their beds at all, as every one admits, and that there is plenty of time available, as is well known to be the case.

Accepting ice erosion as a doctrine now established, as it seems to me we must, we will briefly examine some of the consequences of such erosion. Hanging valleys, U-shaped valleys, aligned spurs, and steepened valley slopes are among the more prominent of these consequences. From their existence we must of necessity infer enormous vertical as well as lateral erosion, such erosion occurring in places where actively moving streams of ice were concentrated in valleys along relatively narrow lines. Along the Inside Passage, and in Yakutat Bay, the two sections immediately under consideration in this paper, the amount of erosion which must be deduced from the evidence is in places not less than two thousand feet vertically; and erosion of this magnitude has occurred along hundreds of miles of fiords.

In discussions of the significance of hanging valleys, it has been rather common to speak as if the main valleys were eroded while the tributaries were left undeepened. This has been done here, as doubtless in other writings, in order not to introduce an unnecessary complexity into the discussion. It would, however, be entirely erroneous to suppose that the lateral valleys were not eroded also. It requires only an examination of the photographs accompanying this paper to see that the normal cross-section of the hanging tributary valleys has the same curve as that of the main valleys; that is, the curve which glacial erosion produces.

From the statement just made, it follows that the level at which a lateral valley now hangs above the main trough is not to be taken as the full measure of vertical erosion along the main valley. That this is true is indicated by the fact that of several valleys tributary to a main trough, no two usually hang at exactly the same level. There may be, and in many cases are, wide differences in the hanging levels of neighboring valleys (Fig. 10); some being perched far up on the mountain side, others so far lowered that the sea water enters and drowns their mouths (compare Figs. 2 and 5), which, however, are still hanging above the bottom of the fiord. Such differences in the hanging level are, in the main, a measure of the difference in amount of erosive work performed by glaciers in the several hanging laterals.

In general, those valleys occupied by the largest glaciers have been lowered most; and it may be stated as a law that, other conditions being equal, the height of a hanging valley above the bottom of the main trough varies inversely with the size of the glacier. The operation of this law is, of course, modified by the influence of varying rock texture, slope and other causes which tend to modify the rate of ice erosion. We are not yet in full enough possession of the facts relating to the process of glacial erosion to warrant an attempt at a full statement of the nature and result of the various influences which tend to modify

the rate of erosion. There can be no question, however, that the nature of the valley rock is of profound importance, some weak rocks being eroded with relative rapidity by small glaciers, other rocks resisting the erosion of even large, powerful glaciers. Two causes, the size of the glacier and the nature of the enclosing rock, are, in all probability, of most importance in the modification of the height of valleys left hanging by more rapid erosion along the main trough.

An argument which has been advanced against the power of glaciers to erode, is the fact that rock islands sometimes rise from the floor of valleys through which powerful glaciers have passed. It has been claimed that such protuberances should have been erased if the glaciers were really eroding greatly. When the operation of glaciers as agents of erosion is truly understood, however, this argument seems to favor rather than to oppose glacial erosion. It is not to be supposed that glaciers would erode everywhere at the same rate. There is naturally a variation in the rate of erosion of a valley bottom dependent upon at least two important influences—nature of rock and rapidity of ice currents—both of which are liable to vary in any valley and thus necessarily give rise to irregularities in the ice-eroded valley bottom. Once an obstacle arose in the path of a powerfully moving glacier, it would have the tendency to split the ice current around itself, much as a sand bar spilts the current of a river. By interfering with the ice current in line with the obstacle, and by causing a concentration of movement on either side of it, the size of the obstacle would naturally increase. Rock knolls, islands and nunataks (Fig. 14) are such characteristic features in glacially eroded valleys that, when the full significance of glacial erosion is understood, I believe they will be found to constitute one of the distinctive evidences of glacial erosion, to be classed with hanging valleys, truncated spurs, steepened slopes and U-shaped profiles.

In discussions on glacial erosion much attention has been paid to rock basins,—basins with rock rims in the bottoms of glaciated velleys, and oftentimes holding lakes. Such basins also occur on the fiord floors of the Inside Passage. Irregularities in erosion, due to differences in rock resistance and in ice currents, readily account for these. As Andrews has shown in his remarkable papers on glacial erosion in the New Zealand fiords, one important cause for such basins, and other forms of vigorous erosion, is the convergence of ice currents in a valley of smaller cross section, causing acceleration of motion. Rock basins must be added to the land forms resulting from and hence indicative of profound glacial erosion.

Another feature at first apparently opposing glacial erosion is that hanging valleys, truncated spurs, and steepened slopes are at times well developed on one side of a main trough and either absent or poorly developed on the other. This, however, seems a perfectly normal result

of ice erosion, for, as in a river, the current naturally at time impinges upon one side with greater force than on the other, as, for example, when by the entrance of a tributary the ice current is pushed against the opposite side of the valley.

A prominent feature in regions of former glaciation, both of continental glaciers and mountain-valley glaciers, is the presence of *through valleys,* that is, valleys in which there is now no pronounced divide. Such valleys abound in the Finger Lake region of central New York, and they are common also in Alaska, and, as Penck has shown, in the Alps. The evidence points to the conclusion that many of these through valleys owe their characteristics to the passage of ice across divides, and the consequent lowering of the divides by glacial erosion. In some places in Alaska, as in the Yakutat Bay region, the ice is still pouring across such divides; in other cases, owing to the shrunken state of present-day glaciers, the through valleys are now occupied by glaciers which flow both ways from a low, flat divide area across which, at a higher stage of the ice, through glaciers once passed. So far as seen in the Yakutat Bay region, none of the through valleys are entirely free from ice; but in many cases the glaciers are so shrunken as to expose the valley form, which is distinctly that characteristic of glacial erosion. In central New York, where the work was performed by continental glaciers instead of valley tongues, and where the ice is entirely gone, the character of these through valleys is easily observed. They are often U-shaped, steep-sided, straight-walled, and possess hanging valleys.

The acceptance of the conclusion that glaciers have been powerful agents of erosion, and doubtless still are where now in active operation, seems a necessary result of a candid consideration of the evidence. Once this conclusion is reached, a number of remarkable phenomena, otherwise not satisfactorily explained, find ready explanation. The belief in glacial erosion carries with it stupendous consequences, for it assigns to glacial action some of the most striking topographical features of regions formerly occupied by actively moving ice. Nowhere is the evidence clearer, or the results more striking, than along the Inside Passage to Alaska, and in the fiords northwest of this, such as Yakutat Bay. For those who still doubt the effectiveness of ice erosion, a trip through these fiords is strongly recommended instead of a study of the weak termini of small, dwindling Alpine glaciers.

THE RELATION OF SCHOOL ORGANIZATION TO INSTRUCTION[1]

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IN the text of an ancient story we are told that man was made out of the dust of the earth, and according to one version, at least, he was then leaned up against the fence to dry. Afterwards the breath of life was breathed into his nostrils and he became a living soul. This venerable myth, accepted in its substance as truth by a part of the human race for centuries, naturally lent its form to educational theory, and thus profoundly influenced the methods employed in training the young. From earliest times down to a generation ago education was a breathing-in process that simply continued and expanded the original act of creation. Then there arose a new conception concerning the making of a man and educational theory is slowly changing its form. Responding to influences from without, life is an unfolding process from within—this is the conception that is now shaping our methods of instruction.

The most interesting of all subjects of study is the evolution of evolution. That the development and maintenance of the organism depend upon its concessions to environment is a fact that has been recognized, in a general way, from the dawn of the evolutionary idea. The formal statement of the theory of evolution was long anticipated by the practical sense of the world in its knowledge of the dependence of the physical organism upon its material surroundings. But almost half a century has past since that doctrine was stated and even now we but dimly see its profound bearing upon the relation of the spiritual life to spiritual conditions. And the extreme newness of a certain phase of this higher aspect of evolution is evidenced by this meeting itself, which is perhaps the first ever called for the distinct purpose of considering the development of the social nature of the human being under the stimulus of social conditions.

The particular agency in social development that it is proposed to consider here is the school. It is not intended to deny that there are other agencies that have a similar purpose; it is the intention, merely, to maintain the thesis that within the range of its possibilities the school should be organized so that it may operate as a social institu-

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tion; and it will be the aim, also, to point out some of the most important changes needed in present school organization that the desired end may be attained.

The chief obstacle at present in the way of socializing the schools is found in their forms of organization. The machinery of the average school is an invention for the purpose of holding a pupil down while we educate him by the breathing-in process. A social institution is an organism; whereas, the school is formed essentially on a plan designed for dealing with a sum of particulars. It is treated as a body having merely the agglutinant characteristics of an aggregation. Few people realize that the transformation of a school of the average type into a social body means more than a change of name; in fact, however, it really means a revolution.

Regardless of outward forms and of protestations to the contrary, the real end of the school has been and still is the individual for himself and not the group. The school desk nailed to the floor circumscribes the space for the individual. The school grade represents an endeavor to get pupils together who are so near alike that they may be treated as an individual. The cry for extremely small classes, the exclusiveness of the small private school, the employment of tutors, all stand for efforts made toward the education of the individual for himself practically in a state of isolation. The dead and persistent drill upon the three R's backed up by the birch, by marks, by bribes, by promises of promotion, by threats and by cajolery has but a feeble socializing power. It is on the contrary essentially individualistic in the unwholesome rivalry which it always promotes.

If any one doubts the barrenness of the social life in our schools let him read as I have done in this the past few days the reminiscent records of students now in the university in which they narrate their experiences in the elementary schools. They tell of a dreary round of lesson learning with a little variation here and there as to the stimuli used, all of which were classed as either personal rewards or personal punishments. It was all summed up admirably by one student who said: "We always had text-books, and definite lessons were learned each day and recited, as it seems now, to the teacher because we invariably looked at the teacher while reciting and tried to see some mark of approval on her face." In the entire series of papers there is not a single instance noted when there was any attempt made to establish relations of helpfulness among the pupils themselves. There is, however, considerable mention of various means employed by the teacher to keep the pupils in a state of isolation from each other. As a matter of fact some of the most elaborate and artistically stupid parts of the school machinery have been especially devised for the purpose of keeping pupils from mutual assistance; whereas, the thing above all else de-

manded in society at large is that its members shall help each other to the utmost. The only places where mutual helpfulness is not recognized as being in every way worthy is in school and in prison; in this particular the teacher behind the desk and the guard mounted on the walls have something in common. It is most unfortunate that this tendency toward mutual assistance is treated as though it were an iniquity—as an especial brand of original sin; while, in fact, it is the latest dawning and most lovable, civilizing trait in human character.

The proposition to transform the school into a well-organized social institution is not merely a matter of abstract theory or pure science. It is a definite expression of a movement to make the schools in common with other agencies a positive force in bettering the conditions of life.

This proposition rests upon the foundation stone in human character that up to date has been rejected by the educational builders—namely, the natural tendency of children toward helpfulness. The spirit of consideration and helpfulness is what we most need in human life and the schools must cherish it in the children and train directly for it. The kindergarten, here as ever, is the best type of what we want in school life clear through the university. Go into any good kindergarten and note how gladly the children participate in the many opportunities for cooperation in living their simple and beautiful life. Go then into the upper grades, and into the high school, and into the university and observe how one by one those opportunities for participation in the upbuilding of the public weal have been withdrawn and mark the degenerative effect of this loss of opportunity upon the social qualities of the pupils!

There are in this country many universities that number from 1,000 to 5,000 students each year. These young people represent a virile period of human life, when hope is young, aspirations are keen and the will is dominant. But when taken in their totality, in their power or in their desire to organize as an influence upon any phase whatever of human affairs, they are as innocuous and as ineffective as a flock of sheep on a sunny hillside in April. There is not a university president, nor a professor, nor a university department of sociology, to my knowledge, that has ever yet organized the splendid native force of a great student body towards any public end that is worth the attention of an intelligent man. Nor does the student body itself show any such disposition to organize. The highest watermark that has yet been touched in fusing together the community forces in the great universities is represented by the college yell for the foot-ball team! No other state institution could so completely withdraw these thousands of young people from a consideration of the interests of public welfare.

Even in darkest Russia, with every influence against them, with no public school system, where blackest ignorance is the rule with the

people, the student bodies in the universities represent perhaps the most powerful hostile influences with which despotism must contend.

This shows the power of student life when it organizes itself under the whip of a great purpose, and it mercilessly exposes the enormous moral loss to society and the delinquencies of an educational theory which permits any diversion of these forces of youth from the work of upbuilding the social and national life.

The economic vandalism of our time can be charged to no one person or thing; but responsibility for it may be laid directly at the door of a school system which permits this social deterioration to begin in the earliest years and thence onward to increase in a steady ratio throughout the higher institutions of learning.

All schools, however, have always had some social life of a more or less organized character. In the plays and games outside of school hours; in the stolen whispers of the study and recitation periods; in the clandestine schemes laid for the discomfiture of the teacher; in the literary societies, and in many other ways, through the exercise of their social instincts, the pupils have managed to make their school days tolerable for themselves and, to a like extent, often intolerable for the teacher. But these aspects of school life have been, and still are, considered as diversions, as incidents and somewhat as detriments to what is called, in school parlance, the 'regular work.' It is largely due to this fact that in most schools the socializing process as yet remains inchoate.

There is a misconception, almost universal, concerning the organizing center of the school as a social body. Recognizing that in the past the chief organizing influence has come through the exercise of the play instinct, the unguarded inference is that it is now proposed to socialize the school through play alone; or, what comes to the same thing, by the introduction of work which shall be turned into play! It is through this perverted idea that the New Education stands charged with triviality in its methods and with a disregard for that robust discipline which comes through sturdy and purposeful work. Nothing could be farther from the truth. Students in the philosophy of education are slowly coming to understand that the spelling-book, as such; that the endless repetitions which usually accompany 'formal number'; that the struggle with words merely for the sake of a vocabulary in reading; that the wrestle with technical grammar as an introduction to the study of language—that all these and other subjects of like kind, as they generally appear in the schools, are essentially unsocial in their influence. Such students believe that herein lies a great obstacle to that reform which seeks to socialize the schools. If, however, this so-called work is to be removed from its present dominating position in the curriculum, it is as yet inconceivable to most people how there can be

anything to take its place except play. It is only too true that in many schools where the old technical drills have been discarded, the teachers have been unable to find anything worthy to take their place, and there at once develops a tendency towards inferior social types of organization. These lower social units taking root readily in a school where many of the old arbitrary means of control have been abandoned, inevitably become immediately inimical to the broader interests of the school as a whole. In this condition of affairs we find that *raison d'être* for the fraternities and sororities in the high schools.

The prime necessity in the social organization of the school is that there shall be an abundance of those activities which are capable of yielding tangible results in worthy products having a common interest. The distinction usually drawn between the activity of play and the activity of work has neither meaning nor value in terms of growth. Both play and work may be good or bad, educative or otherwise; that depends alone upon the motive. The infallible test is found in the character of the output; it is a measure that anyone may apply with ease and directness when education is conceived to be a concern of the familiar things of life.

An educational activity with an organizing value is one which expresses itself through some helpful work. This is not a machine-made definition—it depends upon the nature of things. It is rooted in the fact that every child is a born worker and a lover of work. To work, to do things, to bring about results, useful and beautiful, is just as natural as it is for him to breathe the air. There are no lazy children, naturally. Catch them young and treat them right, and they are all workers and lovers of work. A lazy boy is merely either one who is sick, or one who does not like to do something which a 'grown-up' thinks he should do; his indisposition, if not a matter for the physician, should be placed to his credit. A big boy came to my office one day who was too lazy, the teacher said, to be allowed to remain in school. I asked him what he would like to do if he were left entirely free to choose, and he replied: 'I would quit school and go to work!' I thanked him—inwardly—for his criticism, over which I have since deeply pondered. Doubtless the 'work' which this boy would be able to pick up in the streets would be as little to his taste as were the tasks left behind in the school. For the average employer rarely considers the soul-life of the employed. He stands a good chance of falling into the hands of a man who wants to get more gold out of dry goods and groceries than nature has put into them and he tries, therefore, to make up the deficit out of the boy. So between the teachers who do not know enough and the business men who do not care enough the lazy boys are easily turned into the path of the transgressor. Laziness is the merciful invention of nature, whereby she holds them

for a time at the parting of the ways, and enables them during this period of wavering to escape the stupidity of the schools, on the one hand, and the heart-breaking conditions of business on the other.

It was a bad day for education when it got itself placed over against work; when it made work a penalty for the stupid and a punishment for the perverse who would not allow education to be breathed into them—and education is just finding out its colossal blunder. Figures from the fourth grade up show that, when it is solely a question of school or work, it is work that wins the contest, hands down. Of the hosts that enter the primary grade, practically all the children of all the people, by far too small a per cent. finish the eighth year; of these a still lesser per cent. go to the high school, and beyond this there is scarcely more than a negligible minority. This absorption of child-life by the world's work all takes place in the face of modern educational theory, our advanced views of culture, our legal enactments, and the truant officer!

Any fair test applied to a school will show two things: first, that the pupils are capable of far more productive work than is now called for and, second, that they are anxious for more of it. This fall this question was put to about two hundred pupils from the sixth grade up: If the building were open to you after school, would you like to stay for extra work? What would you like to do and how much time would you use? In the replies received all but twelve or fifteen said they would like to stay from one half hour to two hours on from one to four days a week. The range of choice was practically all among the arts and crafts. Work in the wood shops was most popular, there being about sixty applicants for this, while work in metal, in clay, in textiles, bookbinding, printing, gymnastic dancing, photography and many others had a strong following.

Yet education is not wholly a matter of tasks. This is the pitfall that catches most of our critics who contrast the old with the new. If education were the result of tasks arbitrarily imposed; and if the old set tasks for the pupils that were difficult enough to hold them to the top notch of effort; and if the new levied only those that were so easy that the pupils became dawdlers, then the apostles of the present régime in school would have it their own way. But here is the difference that is world wide. The new, while rejecting the idea of imposing tasks arbitrarily, seeks to establish conditions which challenge the personal initiative. The old over-emphasizes attainment as a quantitative result: The new values attainment only as it represents a quality of mind that has acted through its own initiative. The old recognized as training and discipline the so-called voluntary attention which seemed to be mainly the ability to stare, ox-like, a disagreeable, uninteresting or unintelligible thing out of countenance. The new believes

in the training and discipline that come from the pupil's effort to follow up from premise to conclusion, something which mightily interests him because of its worthy purpose. The old found satisfaction in a state of mind that was quietly receptive; the new sees hope in the turbulence of inquiry; and all of these are irreconcilable differences in kind.

When the work of the children springs from their own initiative, it will become essentially creative and not imitative. The theory that the educational process is imitative and not creative especially in the earlier and formative years of childhood is as old as psychology itself and in practise the proposition stands almost unchallenged. The average curriculum is formed on the idea that the pupils are imitators, the followers of directions, and not creators and it is consequently imposed. The daily lessons in scope and character, the methods of the recitations, the modes of expression are all prescribed and all the activities of the school are reduced as nearly as possible to that monotonous routine known to the devotee of system as 'regular work' which offers no play for the creative intelligence in either thought or deed.

The constructive idea now being realized in various forms of handwork is the thin end of the wedge that is opening the way to reform. Anything which involves the hand immediately arouses the creative instincts. Much of this work is still of the illustrative type, merely reproductive or imitative and in the beginning it was all of that character. In wood, for example, the 'exercises' were all once manacled to a set of models that made no claim upon creative powers either through their use or beauty.

At present, nearly all subjects in the curriculum make some application of the constructive idea. The lessons of history are vivified by reproducing typical creations of other days. Science becomes somewhat more real by the performance of experiments set by book and teacher. Mathematics has been improved through its applications to prescribed construction. Something of both the technique and the spirit of art is acquired by reproducing the work of the masters. This all represents a distinct improvement upon the old régime of books and lectures, and such exercises will always form an organic and necessary part of an educational system.

But the high-water mark in school-teaching will be reached only when such work becomes secondary because it is supplementary and subsidiary. Only when the dominant note of the school is clearly creative does it lay direct hold upon the vital and continuous interests of the children and become essentially educative.

This is true regardless of subject-matter or material on the one hand, and age or sex on the other, and to this fact some curious schoolroom phenomena are due. Parents frequently marvel that the boys of

all ages delight in cooking and textiles, while the girls are equally interested in woodwork and other forms of heavier manual training. The reason, however, is clear. It is not that there is anything inherent in either the dough, or the cloth, or the wood, or the iron, but rather because the work under all these heads is largely creative. It is because an aim is set up that is unique; it is somewhat new because it is personal—it is because the ages-old materials must be combined to fit new occasions that the interest is enlisted and the best original efforts, and consequently the highest educational results, are obtained.

Every creative activity will have its artistic aspect; for when the soul enters a creation, then and there art is born. Art-forms are now rarely creative. They do little more than tickle the sense with the pleasures of a fleeting hour—and they are worth all they cost for that! But when the lives of the children are properly enriched, music, painting, drawing, sculpture, and the rest will come forth as creations—the radiant allies of speech. In language growing fluent and supple, the pupils will learn to wreathe in descriptive, dramatic and poetic forms the subtlest creations of which the human mind is capable.

Creative work transforms the individual. Through it, alone, he grows and maintains a personality that makes him different from others. Through it, alone, his generation rises above all that have preceded. Imitation is a training in conformity. It holds the creative instincts in abeyance until at maturity it is the exceptional man or woman who is not hopelessly bound by the shackles of convention. If he would ever create, he must override the prejudices ground into him by the schools, and, even then, the daring freedom of childhood but rarely comes again. The gospel of conformity teaches that the best has been done—that naught remains for us but imitation. This, too, in face of the practical fact that the discoveries of to-day have sent to the scrap-heap the brilliant inventions of yesterday! The effect is not less marked in the realm of morals. Generally speaking, the ethical code of the school has been copied from that which once served the purpose of the generation that developed it, but it is far below what, under present conditions, the pupils can create for themselves.

The final test as to the value of any piece of educational work in the development of children of whatever intellectual capacity is determined by their appreciation of its worth in meeting a natural demand. Unless their energies are constantly directed toward filling a recognized want, the pupils put forth their efforts in vain, and the routine of the school becomes merely the rattle and grind of empty machinery. Upon one trait in his pupils the teacher may forever reckon: they will always respond to a need which they can really feel and understand. A study of our city parks showed how impossible it was for certain useful and beautiful birds to find suitable nesting-

places in the trees and shrubs. Forthwith practically every pupil in the school volunteered to make boxes for the nests. Whether the smaller children could make an entire box or not mattered but little; the strength of their want through a real sense of the need, coupled with the little they could do, added cubits to their moral stature.

A practical difficulty in the way of teaching children to realize their motives in some useful end, is that to many people it looks too much like common work; there are parents, therefore, who strenuously object. They say their children can get that at home, and that the school should stand for something else—for culture! This is a curious fact, in view of the glorification that labor is now receiving at the hands of the people. However, the large storekeepers do say that this great revival of enthusiasm for labor has not as yet appreciably increased the demand for overalls and jumpers. No one has reported, so far, that the cuts of these elegant and useful trappings of toil are appearing in the latest fashion plates of our high-class tailors. From this it may be inferred that with most people the labor question has not yet gone beyond the stage of academic discussion. Hence the difficulty of getting the pupils actually to work either in school or at home. Last year the children wished to have blooming plants in their school-room windows. They thought to improve matters by substituting for the unsightly pots the more beautiful creations of their own hands which they could easily make in the clay-room. Immediately a parent wrote that if our pupils could find nothing better to do than to make jardinières to beautify the University of Chicago he would take his son from the school—and he did! The kind of school which this type of parent really wants is one where his boy can insensibly acquire curvature of the spine, a sallow complexion, spectacles, and—culture! We have trade and technical schools that give education for the sake of labor; we must now have schools that give us labor for the sake of education.

To sum up, therefore, the resources of the school which the teacher may utilize in the development of a social organism we have on the part of the pupils (1) a natural spirit of helpfulness; (2) an inborn love of work; (3) a desire to take the initiative; (4) an ambition for creative work; and (5) an alertness of mind toward public needs. Upon these foundation stones the social structure must be reared.

That these qualities of character may be normally developed, the curriculum must provide an abundance of suitable material; the class exercises must keep to the forefront matters of public interest and the entire organization must offer a maximum of freedom to the individual who thinks and works in the interest of the common welfare. Everyone recognizes these elements of character as being those which give us the highest type of citizenship in the community at large. It is inter-

esting and pertinent to inquire why they do not give corresponding results in the school. People generally seem to understand that the school should reflect the interests of the community, but the traditions of the school are such that the instant an industry or an art is introduced into the schoolroom the tendency is to erect it at once into a 'subject of study.' This means to the average person that it must have its special teacher, its arbitrary place on the program, and in other ways take a definite setting in the curriculum. Now, there is a vast and an essential difference between this kind of so-called organization attempted by the school, and the actual organization which takes place in true community life. If, for example, under normal conditions, in the latter, a wagon is to be made, the various activities that contribute to that particular end are so correlated as to combine efficiency and economy. Everybody's efforts are directed to that result. There is just so much wood needed and no more. A premium is placed upon the endeavor to use as little as may be consistent with the character of the wagon desired. The same is true of the iron work—no more bolts or bands are made than are actually needed. So, also, it is with the paint; what the wood needs for its preservation and adornment is used, and nothing beyond. But bring these industries into school as 'handwork,' and we find only so many more 'subjects of study' that in some way must be juggled into an already overcrowded program; only so many more teachers that are to increase the wear and tear in already overwrought children. It is no longer a question of doing just as little as is needed, but as much as possible! It is as though the wagon-maker were to go ahead blindly and make a dozen wheels where only four can possibly be used; as though the blacksmith should forge a hundred pieces of iron where but twenty are needed; and as if the painter should demand forty hours for his work when five would be altogether adequate. We are in an incipient stage of development, where there is insufficient attention given to the relation between demand and supply. The work generally in any particular subject represents the strength and the personal push of the teachers, or the reverse. If by superior wit, or by greater cunning, or by sharpness of tooth or strength of claw the ambitious teacher is able to get a lion's share of the program, his particular subject may be correspondingly magnified, even to the detriment of all others.

If the school is to approximate still further the ideals of community life it is necessary that there should be a more flexible adjustment of the workers to each other and to the thing to be done. The grouping and distribution of the pupils should be based upon the nature of their work. The school grade as now generally constituted is a pure fiction in philosophy but it is a stubborn and unreasonable fact in practise. Under the domination of the grading system, the school reverses or

ignores most of the principles that control people in practical affairs. Under its operation, it compels the teacher to lay the greater emphasis upon the similarities among pupils, and to ignore differences, and it places a premium upon uniformity. The more closely the school grade approaches its ideal, the more strictly must each pupil work for himself; while the closer we approximate the grouping required by the social ideal, the more earnestly must the individual strive for the whole.

The school grade aims at a certain dead level of uniformity in three things, namely, age, knowledge and skill. These rigid conditions have imposed the stamp of their own arbitrariness upon the selection of subject-matter and methods of instruction, and they render it impossible to realize the highest ideals of social and civic life in the school. The grading system was established long before child-study opened the eyes of teachers, and it represents the quantity idea in education as opposed to that of quality.

In school, not all of the teaching is done by the teacher; the younger children are constantly learning from the older. Experience shows that when pupils have the opportunity to organize themselves for work they form groups which in many instances utterly ignore the age limits set by the grade. The younger pupils gain in skill and knowledge, and the older have lessons in consideration for others and in responsibility that in a graded system must remain forever untaught.

It is equally undesirable to grade pupils on the basis of equality of knowledge. Outside of school such an aggregation of people would be considered a stupid company, with but little chance for improvement. It would distinctly improve the situation to bring together in some common enterprise pupils who differ widely in both knowledge and experience. This applies especially where the pupils are employed in doing rather than in talking. The less capable learn from those who know more, and the latter will learn to work from the strongest stimulus that can move anyone—the necessity of making knowledge immediately intelligible and available for others. The nearer the conventional grade is approximated, the less there is of such a motive; for a similarity of knowledge makes each one useless and uninteresting to every other.

The same argument applies against the requirements for a parity of skill. Every pupil has a certain skill of his own, and his work should so relate him to others that he may make the most of it. He need not be 'graded' with those having equal skill in the same direction. This point finds illustration in the building of a house. In this there may be six or eight different kinds of workmen employed. No two have quite the same skill, in no two is it required. Each one does what is needed and what he is best able to do. The group is so organized that the house-building progresses rapidly and well; but the

organization bears no resemblance to that arbitrary aggregation known as a 'grade.'

The effect of the present grading system upon the treatment of subject-matter has been pernicious. It has led to endless attempts at cross-sectioning subjects, in order that certain portions may be trimmed down to fit the pigeon-holes of the grades. This is reflected in thousands of text-books, and there is scarcely a subject that has not been marred by the ill-advised analysis.

The evils of arbitrary grading are not less marked in their effects upon the teacher. The notion that each grade must have its method is most persistent at the two extremes—the kindergarten and the high school. Those entering a course of training for the kindergarten are loath to trouble themselves with what lies beyond; and the would-be high-school teacher is apt to regard a suggestion that he look into the nature of elementary instruction as a reflection upon his intelligence.

The influence of the grading system upon the pupil is necessarily bad. It retards his progress through the elementary school, and it fosters selfishness. In the wake of the grade, trail many evils that fret the children. Not the least of these are the marking system and formal examinations, which have done more to introduce and foster knavery during the impressionable years of childhood than all other agencies combined. Under such unphilosophic and arbitrary stimuli to action, it matters not how hard he may try, no pupil can grow up wholly honest or unselfish.

Grouping of pupils under the ideals of the new education rests upon a principle radically different from that which now prevails. Under the old ideals, the children must exert themselves to excel each other. Under the new, members of a group must exert themselves to help each other. In the former, the work is so planned that each must strive for the same thing—the very same bone; in the latter that—as in the building of the house—the best effort of each is a needed contribution to the welfare of all. Each, therefore, must encourage and support the other. It is the operation of this principle that at once divides the light from darkness, that lifts civilization out of barbarism, that filters righteousness from iniquity, and that will finally give us the ideal school. The problem of grading and grouping of pupils will be solved when the children are permitted to plan work for themselves that demands cooperation. It must be for an end that no one by himself can attain, that, in school as well as out, the principle may be established that no one can live unto himself alone. That is the supreme fact in democracy.

The reorganization of the schools on the basis of community life makes an imperative demand for a new type of trained teachers. Academic training has been amply provided for and it hereafter will

be assumed. The past generation has done practically all that need be done to place within easy reach of every intelligent teacher whatever it is necessary to know concerning special methods. Within the same period the subjects of psychology and child-study have been thoroughly worked over, and the results have been fully and clearly presented. This part of the teacher's training, hereafter, will not become of lesser importance, but it will be more and more assumed as a preliminary to the newer training which the public is now demanding. The greatest need of the schools is teachers who have the power to reach the public mind. The power to teach the children will be taken for granted.

The new type of training will not be found in a further elaboration and intensification of book study and theoretical discussion; nor will it appear in a further development of specialization as that is now commonly understood. It will be based upon actual 'field work' carried on in the community at large. That is, the teachers in training must study the needs of a community as they manifest themselves in its daily life; they must, in fact, in some way become actual participants in that life. No other kind of training will ever equip prospective teachers to answer questions which the public is now asking. The school must go into the service of the community more directly, and the community must open itself up more freely to whatever service the school can render.

Up to the present time the training schools for teachers are all modeled upon the plan and after the ideals of the older educational institutions of an academic type, and these, in their turn, grew out of the cloister. The training schools for teachers, on the contrary, should be modeled rather upon the plan of the so-called social settlement, and the ideals of the teacher must become more nearly allied to those of the settlement worker. Every school should be so organized as to draw all the people together for the purposes of work, of study, and of recreation, as the public library now attracts people who wish to read. To this end, the studios, the workrooms, the laboratories, and the libraries of the schools should be open under the supervision of the teachers, as public libraries are under the librarians, to suit the convenience of the people. They should be open at least as many hours as the saloons. A training school for teachers that could place its prospective graduates for at least a year in such intimate relations with community life as the settlements afford would give them the best possible preparation for undertaking with the people the joint task of educating the children. This does not mean, of course, that such training can be acquired only in the reeking and congested districts of the cities. Every locality in city, village, and country, should offer some opportunity for the practical training of teachers in the science and art of working with people. The teacher should take a leader's

part in the debate of every question that relates to human welfare. It is only by the most active participation in public affairs that he can keep himself in proper training for the task of teaching the people's children.

The coming era of education will be marked, not by its material resources, but by its teachers. Our school houses are good enough; now let there be trained teachers, then we shall have schools. Such teachers will be equipped, of course, with knowledge; but above all they will be trained in discernment—in the power to see and appreciate the fundamental things of human growth and in its output of character. They too must work with the children, not alone for them, and be creative; to create they too must be free. The present system that grinds and chafes at every move was developed under archaic ideals; it has become antiquated and in large measure useless. The organization of the schools must grow out of the professional necessities of the teachers, the greatest of which is that even the poorest shall be free to put the best of himself into his work. Under such conditions every teacher and every child will become a positive creative moral force in the upbuilding of the social structure.

IN SEARCH OF TRUTH[1]

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AT the January meeting of the Astral Club at Alcalde, Mr. Arthur Grimshaw, of Berkeley, the newly appointed science teacher of the Alcalde Union High School read a curious and interesting though revolutionary paper on the 'source of knowledge.' His title was 'What is Truth?' This paper was highly appreciated by the club as the example of the best results which can be attained on the material plane of thought. The author's failure to rise to the heights of astral conception was however painfully evident. It is plain that in the laboratories where his training was secured all esoteric sources of truth have been ignored. But as the Astral Club of Alcalde, though I say it who should not, is nothing if not open-minded, it shall be the duty of the secretary to transfer to this record the substance of this young man's views on the tests by which truth may be known.

Mr. Grimshaw began by a discussion of the significance of 'philosophic doubt' whereby men question the only things they know to be true, in the hope of proving the reality of things they know are not true. For if you can show that truth and falsehood are identical in the one case, it lends probability to the theory that falsehood is truth in other cases. On this general argument are founded many forms of modern philosophy and of ancient philosophy as well. Mr. Grimshaw said:

"What I mean to show is that all truth is truth so far as it goes. The things we know to be real are real and we are not deceived in believing in them. The proof of the reality of an object, the truth of a proposition lies in the fact that we can accept it and translate it into action, into life. If it were not true we could not act upon it. Acts based upon it would sooner or later put an end to existence.

"The real nature of an object before us may make little importance to us. It may be solid rock or empty vapor, if we choose to let it alone. But the moment we form relations with it its reality becomes a vital matter. If it is a rock or an apple, then rock or apple it is in all its relations. If we view the apple as something essentially different from what it is, there will be similar errors in our thought of other things. If we are deceived as to the rock we shall have unsound notions as to other things.

[1] Being further extracts from the Journal of the Astral Club of Alcalde.

"Poisons would seem as foods, foods as poisons; pleasures as sins, and sins as pleasures. The whole sanity and accuracy of life would be destroyed. For the security of action is conditioned by the exactness of our perceptions of the relations of external things and by the correctness of our reasoning in regard to these perceptions."

Mr. Grimshaw, falling back on the lore he had learned in school, said:

"In psychology the term *reality* is sometimes applied to a sense perception which is based on an outside influence acting then and there. In this sense the *reality* is not the external influence itself, but our direct or normal perception of it. Thus, the impression made by the sound of a gun would be a reality when the pressure of air waves reached the brain, though the explosion may have taken place some seconds before. This reality as it comes to the brain should bear a definite relation to its source. In other words it must give the mind such information that the actual occurrence may be correctly interpreted. On its correct interpretation the fitness of our response in action must be conditioned. The term 'common sense' is applied to the normal working of these brain processes. An external stimulus produces a reality. The reality is transmitted to the brain where it is considered in its proper relations. Afterwards an impulse to action passes along the motor nerves to the muscles, which are the servants of the brain.

"In simple matters, as those pertaining to the apple, the dictates of common sense are obvious enough. The feelings are not moved by an apple, and our recognition of its nature is clouded by no illusions. But there are many relations in life in which 'common sense' does not find the problem so easy. If we examine the actions of ourselves and of our fellows, we shall find that the 'common sense' of different men does not act in parallel ways, and what seems to one wise or natural becomes grotesque or absurd to another."

Mr. Grimshaw then gave a number of illustrations of thought or action in which the 'common sense' may be deceived:

"You are in a railway train which is waiting on a side-track. Another train comes in sight, its motion seems transferred to your own train, but in the opposite direction. This motion continues until the other train has passed. It ceases suddenly, when you can almost feel the jolt of its stopping. But from other observations you know that your train has not moved in all this time.

"This is a simple illusion, easily corrected by the mind before it passes over into action. Let us look at some others. The story is told of a merchant who, smacking his lips over a glass of brandy, said to his clerk: 'The world looks very different to the man who has taken a good drink of brandy in the morning.' 'Yes,' said the clerk, 'and he looks different to the world, too.' Now, which is right? Is the world

different that it looks brighter? So it seems to the man's own 'common sense.' Or is the difference subjective only, in the man himself, who has lost his bearings to the outside world?

"The revered sage of Los Gatos, Brother Ambrose Bierce, tells the story of a man who visited a naturalist in San Francisco, and remained over night as a guest. The naturalist was fond of snakes and had several of them in the house. When the visitor retired at night he looked under the bed and found a great coiled serpent, who watched him with glittering eyes. These eyes made some strange impression on him, and in the morning the people of the house found their guest kneeling on the floor, dead, his open eyes still staring in horror at the thing under the bed. This thing was the stuffed skin of a kingsnake with two shoe-buttons for eyes. The 'common sense' of the man told him that the snake was charming him, and in the belief that he was charmed to a horrible death he must have perished. If he had not believed that snakes have the power to 'charm' and to kill, surely he would not have died.

"It is said that a ship once landed on a barren island in the Pacific Ocean. Its passengers brought with them the materials for a house, which they set up, to the surprise of the natives who had never seen a wooden house before. They put in it blankets and cooking utensils, and after a day or two they set up near the house on a solid foundation a long tube through which they gazed by turns at the sun. After watching the sun for a single day, they hastily returned to the ship, carrying the long tube and the blankets, but leaving the house and everything else of value on the island. The delighted natives took possession of the house and they hold it to this day. But they look in vain for the return of the foolish people who left it there.

"Men who have traveled in Mexico tell me that all along the coasts of Sinaloa, people are engaged in digging for buried treasures under the direction of men or women in San Francisco. These people have never been in Mexico, but they are said to have the power of seeing clearly objects not before them, in any part of the earth. There is a very old legend current which tells that a pirate ship, hard pressed by the Mexican soldiers, landed on the Cape of Camarron near Nazatlan, where the buccaneers hastily buried a vast treasure of silver, after which they all fled. A man is engaged to-day in boring a tunnel into solid granite and lava to find the treasures thus laid away. A woman, in a shabby Sacramento Street boarding house, claims to see in her trances the inner secrets of the mountains and directs all these operations. Our common sense or our experience may condemn the whole operation as ridiculous but the transit of Venus seemed equally absurd to the local critics who occupy its abandoned shelter.

"One man takes a forked rod of witch-hazel, and, going over a tract

of land he feels the fork twist downward at a certain point. He digs there and finds a well of living water. If there is much water the rod turns more vigorously or even turns the other way. Another uses the same rod and finds coal, iron, gas or building stone—whatever he may seek. To do this he has only to attach to the branch of the rod a small fragment of that which he would seek. Thus a dime may be attached if one is seeking for silver, a five-dollar gold piece if one looks for gold. In California where there is no witch-hazel the mountain willow serves the purpose best, because there is water in its make up. But even the madrono or the azalea can be used in an emergency. A man once tried to bore for gas on a certain tract of land in southern Indiana. He engaged a soothsayer with a witch-hazel rod. But the wizard, finding the territory too large to be gone over in this way, makes a little rod, parlor size, and taking the map of Vanderburg county, goes over it with the instrument. The result was just as satisfactory. He chooses a point on the map, they bore the well in accordance with the rod's directions. Plenty of gas is found, which proves the accuracy of the method. As Lord Bacon once observed 'men mark when they hit, but never when they miss.' Still another man wishes to find the material of which a star is made. He takes a tube of metal with lenses and prisms of glass and turns it toward the star. Speedily, by means of lines and streaks on the prism he has his answer, and the composition of a vast sun, so far away that the light which left it in the days of Cæsar has never yet reached us, he describes with confidence. Then he turns his tube on the Pole Star and tells us that it is made of two stars, one a great sun which we can see, and the other a smaller sun which we have never seen and which we can never see. Is all this real? If the spectroscope tells the truth where it speaks in such bold fashion, may we not trust the witch-hazel, too, in its more modest claims?

"An astronomer traces the course of a far-off planet and finds that its orbit bends a little from a perfect ellipse. From this fact he concludes that another planet must be coming near it to attract it. He goes to work to determine the size of this other planet and the place in which it ought to be. When his calculation is finished the telescope is turned toward this place, and the unseen planet is there. If the mathematician through his instruments be thus sensitive to far-off matter in infinite space, may not the clairvoyant through her sensitile-projectile astral body be equally sensitive to a mass of silver?

"Once in a trance a finely organized adept or 'medium' wandered in her astral body through the open belt where the souls of the planets wander at will. While there she heard the comet-shriek, the cry of a lost planet soul, the most terrible sound that rings through the heavenly spaces of the zenith. Is not her testimony to be received with that of the other astronomers?

"From shore to shore across the Atlantic Ocean runs a metallic cable. By means of electric batteries, magnets and sparks, a message is conveyed from one end of this to the other. Messages have been sent so many times that the most sceptical can not doubt the fact. By such means a wanderer in any part of the world may be found and called home, or if need be, sent still further on. Most of us have seen this done and all have heard of it. Because it has grown familiar it seems real to us, and its mystery is dissipated. But why use the metallic cable at all? What occult power lurks in metal? Why must we work always on the material plane? Why not use the air? And indeed the air has been used and with wonderful success. But let us not stop here. Why not use the invisible ether, along which so many forms of energy are propagated? Why not use the boundless sympathy of life? In Europe there is a large species of snail which runs up and down the cabbages feeding on their leaves and is very fond of its mate. It too has been used in telegraphy. Leave your sweetheart in Italy when you come back home but leave her with a large piece of cardboard and take another like it for yourself. On each of these write a number of sentences of sentiment and affection—quotations from the poets, the finest possible to your literary taste, Browning, Tennyson, Wordsworth, or the latest topical song—any of these will do. Then take for yourself one of a devoted pair of snails, leaving the other with her. At an agreed moment (standard time, making allowances for differences of longitude) place your snail upon the card and she will do the same with hers. Your snail will creep to any sentiment you choose as you direct it. Hers is left free in its movements, but it will follow the same course that its mate has chosen. Thus the sweetest messages can be sent across the ocean. The last word of the snail in America, 'All's well,' or '*Non ti scordar di me,*' can be made to echo sweetly on a far-off shore. This is the *Parasilinic Telegraph,* no invention of mine, but the actual work of an ingenious 'psychic adept.'

"But why use the snails? Surely their cold slimy bodies are not more forceful than the throbbing heart and eager brain of man. Surely they are not more sensitive than his astral form. Let the snails go. They belong to the crude beginning of astral science. You have only to sit in your room alone in darkness, and by intense thought and irresistible volition you may set the whole ether of the world in palpitation with your dreams and desires.

"To your thought the 'sensitive' you love will respond. Her astral brain will register your ether throbs. 'It is my wish': that is enough for her. But you can do more than that, if we may trust the records. Your own astral body may be sent across the ocean on the tremulous ether and it will appear to her in her dreams or as part of her realities. While the absence of this body may be a slight inconvenience to you,

for you must sleep or suffer while it is gone, it will be a source of joy to her. It may plead your cause for you in a way which protoplasmic bodies can never imitate. That this is not imagination or illusion we have abundant testimony, if the word of man unverified by instruments of precision is convincing to you. Thought and ideas, we are told, may be 'impressed on consciousness in solid chunks without waiting for words or clicks or other means of expression or for a lightning train to convey them,' and there are thousands of records to show how this is done.

"But you do not stop with the expression of your power over the ether and the astral messages it is the function of the ether to carry. You may exert control over matter itself. Mind is matter's king. Matter is the vassal of mind. Then under the force of mind, matter will change or vanish. Recent experimenters claim that by gazing at a photographic plate in the dark, an impression can be made on it. This is the mind flashing out through the human eye. Then whatever is in this 'mind's eye' should appear on the sensitive plate of the camera. But greater deeds than these were done long ago, as our honored president once pointed out, and to my mind they are told in records better authenticated. The sagas tell us that Odin wished to secure the golden mead of the giants that men might drink it and be strong as they. After great labors he came to the mead. He found that the giant Suttung had concealed it in a great stone house, to which Odin could get no key. So Odin and his friend the giant Bauge sat down before the house and gazed at its walls all day. By this means they made a small hole in the rock, and changing himself into an angle worm Odin entered the hole and at last carried the golden mead away in triumph. The influence of this golden mead is, no doubt, still potent in Odin's descendants whose glances have marvelous power.

"There was once a California nurseryman who had a good business and was making money, as the phrase is. So he put aside all the fruit trees which would sell and devoted himself to making others which would not. Each year he trimmed his plums and apricots and lilies and poppies, taking away the pollen which nature had provided and putting it on flowers to which it did not belong. Each year he planted thousands of seeds of many kinds, and when the plants came up, he pulled up nearly all of them and burned them in a great bonfire. Meanwhile he made no money, and lost little by little all that he began with. Then men began to see that all fruits and nuts and flowers changed under his hands. The plums grew very large and very juicy, red, blue and white and more on the tree than men had ever seen before. The lilies and the poppies and all the other flowers grew larger, the cactus lost its thorns and the onion its odor, the chestnut bore its fruit with its second crop of leaves and all things which he touched turned

into something better or handsomer, and every year he pulled up nearly all that he had and burned it in great windrows. And foolish people said that he was a wizard and they came from great distances to see him at his work. And there were a few who thought that they understood.

"There was once an old white-haired man who came to an assemblage of scholars, bringing with him two bars of wood connected by bands of iron. Fifty-three years before he had left his home on the bay of Quinté, in Ontario, to show these bars to the world and to give to mankind what it never had before, control over 'The Unconditioned Force of the Universe.' This force through this little machine would 'revolutionize human industry, economize human labor and relieve human want.' 'Gentlemen,' said the old man, 'I gave up the free and easy life of the Canadian forests, I sought my home among the dwellers of cities, I have sacrificed fifty-three years of my life upon the altar of my desire to benefit mankind. In three weeks more my invention will be perfected and through these bars the unconditioned force of the universe will do its works for you and for me. The time has gone by,' he said, 'when the recognition of my principle would have pleased my ambition. I love my race, and I wish to do them good.' Two years more went by, the unconditioned force lacked but a few days—just one more week—of accomplishment, and in that week the old man died in the poorhouse of Monroe County, Indiana, and in the dust and cobwebs in an attic of a neighboring college the model of the machine to be controlled by the unconditioned force of the universe still awaits the touch which for the first time shall make it run; and there were some who called the old man a 'wizard,' and some a 'philosopher,' and because fame has forgotten his name, I speak it here—Robert Havens. And in both these cases, and in all cases, what is our test of truth?

"Not long ago, on the plains of Texas, by order of the government of the United States, tons of gunpowder were exploded. A great noise was made, the smoke arose to the skies, and then all was as before. The purpose of this was to produce rain under conditions in which common sense said rain was impossible. While these conditions remained there was no rain, but the wisdom of the experiment has the official stamp of the United States.

"Not long ago, and I am sure that the good people of Alcade will remember this, some enterprising men had bought the dry bed of a river in southern California. It is filled with winter floods in the rainy season, while in summer it is white with granite sand and barren stones. At best its boulders can only produce a scant growth of chapparal and cactus. Yet when it was announced that a city was to be built on this land, men grew wild at the thought. All night they

stood in the streets of Los Angeles, each to take his turn in buying its town lots. And the people who bought these lots were guided in one way or another by what they termed their 'common sense.' The sense of great wealth was in the air, and even the wisest were carried away by it. 'The millionaire of a day' takes the breath of his brother millionaires.

"At Denver not long ago a man insisted that he had the gift of healing. A wild hermit from the plains; some called him crazy and some called him a prophet. But the gift he had, or seemed to have, and thousands of sick people and well crowded around him to be touched and healed. He could not touch them all so he blessed their handkerchiefs, and his power passed over to them. Men and women whose ills gallons of patent medicines had failed to assuage were healed at once by these pieces of soiled cloth. And testimonials such as they had once written for these same patent medicines, they now freely wrote for him.

"But, after all, is there such a thing as disease? Surely man 'made in the image of God' is made in the image of perfection, and what is perfect can not be marred or destroyed. May not disease be the greatest of illusions? May not all pain be a nightmare dream from which we should escape if we were once awakened?

"Many a school of healing has been based in one way or another on these propositions. In a hundred different ways at a hundred different times men and women have found that they could heal pain by the suggestion that pain does not exist. If pain is disease, then shall we not heal all diseases in this way? But some say that pain is not a disease, only a warning that disease is present or coming. Pain is the signal that something is going wrong in the mechanism of the human body. The signal may be unnoticed it is claimed. We then feel no pain but the injury remains, for it is the cause of the pain and not the pain itself. By persistently turning the mind away from these signals of distress sent up by the bodily organs, we may come at last to be incapable of receiving them. We are then free from pain, and our minds may be filled with a sweet serenity very satisfactory to ourselves. Now, which of these is true? Are we ill when we feel pain, well when we do not? Or do we feel pain because we are ill and does the illness pass when our feeling is gone? May it not be true that this is a dangerous and selfish serenity? If it does not mean the checking of disease, but only the closing of our eyes to its ravages, then have we really gained anything? To turn from pain is to turn from all outside impressions. To close the mind to the information given by the senses is to destroy reality, to make activity impossible, to cease to do our duty in the world. This is to cease to grow and to become a burden to our friends and a cumberer of society. There is nothing more

noble than serenity amid trouble and distracting effort. There is nothing more selfish than the serenity which is bred by immunity from pain. But to many people, existence without pain, without sensation and without action represents an ideal of the soul. Many well-to-do women of leisure are devoting their lives to the cultivation of this condition, and incidentally neglecting their children and driving their husbands wild by the process. It is not alone faith in a theory of disease or a theory of non-existence which may produce this result. Faith in a celery-compound, an electric belt, or a mud idol may produce the same sweet serenity, the same maddening indifference to all that is real or moving in life. The walls of certain churches in Mexico are covered with the offerings and pictures of those who were saved by their vows or by appeals to some saint. 'But where,' said Lord Bacon, long ago, 'are the pictures of those who were lost in spite of their vows?'

"It is true that to cultivate a cheerful temper, to look on the bright side of things, to laugh when we can and be hopeful under all conditions is good for the body. The food is better assimilated, the blood runs faster, one can do more and better things, and come in closer relations with the realities of life. But conversely, when one meets most manfully the needs of life, his pulse beats more quickly, his brain works better, his liver gives him less trouble and he is naturally cheerful and hopeful. The cheerful man does not dodge pain, he overcomes it. He does not selfishly shrink from reality and turn to introspection and dreaming. He faces the world and makes it his own and takes manfully the pain his efforts cause or which in the progress of life he can not avoid.

"It is possible to go much farther in the direction of the banishment of pain through the thought that pain does not exist. Then take more pain and it will become at last an intense pleasure; when the mind is in the grasp of absolute torture, it is possible for the brain to feel it as with spasms of absolute delight. It is not easy to do this but can be produced by excessive belief in the unreality of common things. The brain half-maddened by pain is open to suggestions from other maddened brains till a fierce wild ecstasy is the final result. This fact explains the strange rites of those sects of self-destroyers which rose in the middle ages, the flagellantes, penitents and the rest. Even yet, the last of the penitent brothers at San Mateo in New Mexico in the passion week torture themselves in the most revolting fashion by crucifixion, whipping and the binding of huge cactuses on their backs. By hideous tortures they expiate in one week their many heinous sins of the whole year. Just as the suggestion that disease is an illusion may conceal pain, for those who give up everything else for healing, so does the suggestion of infinite pleasure conceal for a time the most exquisite pain. But in the one case, as I believe, the disease goes on unchecked, so in

the others, the wounds of the whip and the cactus stab remain as realities when the illusion of joy has passed by.

"In Orange County, California, there is a religious sect which finds the old Bible of our race, the Bible of Moses and Job and Jesus and Paul, an outworn book, no longer fitted for the aspirations of man. This bible is still tinctured with the gospel of selfishness, for it recognizes private ownership of land, and goods and men. 'To honor thy father and mother' implies special ownership of them, and the higher life demands that there should be no respect of persons. There can be no personal claims of any sort if all are to be as 'angels in heaven.' Its command 'thou shalt not covet thy neighbor's goods' implies the neighbor's ownership of material things, a relation which must degrade all who submit to it. 'To render unto Cæsar the things which are Cæsar's' is an outworn recognition of powers that be but which ought not to be. Clearly a new bible is needed, and one of the members of the sect sat down by a typewriter (presumably not his own property) and wrote a bible. It was not his own composition, but that of the Almighty, for the writer simply lent the hands with which divine power did the work. As his fingers played over the Remington keys, he thought of anything or everything except his writing. The result was the book of Oahspe, the Bible of this new dispensation. And the name of the book arose naturally. One looks up to Heaven, and he says 'Oh,' then he looks down to earth and says 'Ah,' and between Heaven and earth is Spirit,—Oahspe!

"In the City Park of San Francisco is the wooden image of some monstrous creature carved by the Indians of Queen Charlotte Sound to express some phase of their mystic devotions. This image was stolen by a Norwegian sailor. Its makers resented its loss by a series of incantations so horrible that they took effect in the image itself. The idol came to San Francisco, bringing sickness, shipwreck or failure to all who touched it. Even now while it rests on a shelf in the Park Museum in apparent quiet, its evil power is shown at night in the smashing of vases and the overturning of bottles. Something of this kind takes place whenever the image is left unguarded. A man who had charge of it for some time avers that one night the creature rose up in living form and seized him in its clutches, and only by the most violent efforts could he make his escape.

"When an electric current, whatever that may be, is passed through a glass tube from which most of the air has been exhausted, various peculiar phenomena are shown. There is an appearance of bluish light, and from certain parts of the apparatus peculiar rays are given off which do not appear as rays at all. Ordinary light rays pass readily through water, glass or crystal, and we call these objects transparent. Through wood or cloth or stone they will not pass; hence these objects are said to be opaque. And the rays of light may be diverted from

their course by passing at an angle from one transparent body to another. This property, known as refraction, is the cause of the formation of images by convex transparent bodies or lenses. But, strangely, the rays of light above mentioned do not act like ordinary light. All objects are transparent to them, though not in equal degree. Not being stopped by dense bodies they are not refracted. Not being affected by lenses they do not produce vision in the eye. As we can not see them to the eye they are not light. But their effect on chemical decomposition is the same as that of light. Hence while not available for vision they can be used in photography. But not being refracted they produce no definite image on the sensitive plate. But they may give rise to shadows. They do not pass through all opaque objects with equal readiness. Hence to place an opaque body between the rays and a sensitized plate would be to cast some kind of a shadow on that plate. The shadow means an arrest of the chemical changes which are the basis of photography. Then if the opaque body be not in all parts of equal density the shadow becomes deeper in some places than in others. This gives on the photographic plate some idea of the intimate nature of the object photographed. For the density is not merely a matter of the surface of bodies. It pertains to the interior, which in an opaque object can not be seen, but which nevertheless may be photographed in this fashion by these peculiar rays.

This line of investigation was lately developed in experiment by Professor Röntgen, and the strange character of the 'X-rays' or 'cathode rays' is now a matter known to every one. By means of these non-refracting rays, shadow photographs can be made showing the bones of the skeleton, imbedded bullets, the contents of a pocket-book, or any similar hidden object which has a nature or a density unlike that of its containing surface. These experiments of Röntgen have been varied and verified in every conceivable way. A wonderful mythology is growing up around them, to the confusion of those who have not paid attention to the series of experiments which made Röntgen's discoveries simple and inevitable.

"For example, in a thousand places the Röntgen rays and the bacilli of disease are made to work together to fill the purse of the enterprising physician. The doctor examines the internal organs of the patient with the fluorescent tubes. He finds out how and where the germs of disease are working their devastation. Then he turns the mysterious X-rays upon these germs and they are checked in their career of ruin: shrivelled up, it may be, under this marvelous light, as caterpillars shrivel on a hot shovel. Another physician I know of distributes his remedies by electric wire, one end in the bottle and the other in the mouth of the patient, miles away. Still other physicians, wise in their generation, use the X-rays and the microbes and the electric currents with other mysterious agencies equally for their own profit

or comfort. Now that the X-rays have become somewhat familiar and matter of course, the still more wonderful emanations of radium are made to do the same things and in a fashion equally regardless of the lessons of chemistry and of physiology. The medicine man of the Modocs by other incantations of his own calls up the microbe of disease which he finally spits out, a trout perhaps, or a wood-boring grub or a small lizard—from his own mouth. There have been occult and esoteric methods in medicine since the first Old Man of the Mountains learned to look wise. The rabbit's foot for good luck, the cold potato for rheumatism, celery for the nerves and sarsaparilla for the blood are typical methods as old as humanity. But quackery and pretense does not diminish our debt to honest medicine and surgery however much it may tend to obscure it. Some one asked Dr. Mesmer, the great apostle of animal magnetism, which was the form taken by 'faith cure' in the last century, why he ordered his patient to bathe in river water rather than in well-water. His answer was that 'the river water was exposed to the sun's rays.' When further asked what effect sunshine had other than to warm the water he replied, 'Dear doctor, the reason why all water exposed to the rays of the sun is superior to other water is because it is magnetized—since twenty years ago I magnetized the sun!'

"I see in the Alcalde *Gazette* that Madame de Silva, a prophetess and seer of visions, seventh daughter of a seventh daughter, born with a caul, down at the American House, is prepared to diagnose all diseases from the examination of a lock of hair, and that Wong Chang, the Chinese doctor, is prepared to do the same and ask no questions. How does this differ from the power of Cuvier to draw a bird from a simple claw or that of Agassiz who could restore a whole fish from one scale?

"Throughout the middle ages experimenters of all grades were engaged in the task of finding the means by which base metals could be transmuted into gold. It was possible in the chemical laboratory to do many things which seemed equally difficult and to the common mind far more mysterious. In the philosophy of the day, and perhaps in our own time as well, there was every reason to believe that the transmutation of metals was possible. But it never was accomplished and many a learned alchemist went to his grave, the work of his life a confessed failure.

"Yet this very day, the daily press, which is responsible for so much of spurious science and mental confusion, gives the record of successful alchemy. One famous metallurgist of world-wide reputation (all these men have 'a world-wide reputation with one another'), has subjected silver to great pressure till it becomes yellow, soft and heavy just like gold. All the difference is in the density—16 to 1. Condensed silver is gold, so the newspaper maintains, and the problem of alchemy is solved at last. By these experiments, six ounces of silver make but

four ounces of gold, one third of the substance being somehow lost in the process. But with improved appliances this third should be saved and the finances of the world may be reconstructed on a basis of genuine bimetallism, gold being made when wanted from the condensation of silver. Yet all-important as this discovery should be, neither chemistry nor finance pays any attention to it. It belongs to the science of the newspaper having only the validity of a 'fake advertisement.' 'Common sense' demands that the experiments be verified and the steps which led to them be made known before considering for a moment the probability that there is any truth in the newspaper statement.

"Now how amid all the wonders of science, non-science dreaming, fakery and insanity is the common man to find his way? How shall he recognize the claims of science among all the other voices and noises in this vociferous world?

"This is my answer, and I believe that it is the answer of science. As to many things the common man may not know at all. Where he is not concerned in any way so that error and truth are alike to him because they can not affect his action, he may be powerless to decide. It is not always important that he should decide. 'I do not know' is the affirmation characteristic of the wise man. It is safe to believe mildly in mahatmas and norms and hoodoos and voudous if one does not regulate his life according to this belief. The vague faith in protoplasm, in natural selection or in microbes which the average man possesses will serve him no better if it is put to no test. The difference appears when one acts upon his belief. The nearer one's acquaintance with molecules or protoplasm, the more real and more natural do they appear. The microbe is as authentic as the cabbage to one engaged in dealing with it. Protoplasm is as tangible a thing as wheat or molasses. But the astral body and the telepathic impulse become the more vague the nearer we approach them. They are figments of the fancy, and their names serve only as a cover for our ignorance of the facts. The charm of such words as Karma, Avatar and Kismet lies in the fact that most of those who use them have no idea of what they mean. Lack of meaning or ignorance of meaning lies at the foundations of most occultism. Scientific induction in its essence is simply common sense. The homely maxims of human experience are the beginnings of science. To know enough 'to come in when it rains' is to know something of the science of meteorology. By scanning the clouds we may know how to come in before it rains. By observing the winds we may tell what clouds are coming. By studying the barometer we may know from what quarter the winds and clouds may be expected.

"The discoveries of science are made by steps which are perfectly simple to those trained to follow them. No discovery is made by chance in our day. None come to contradict existing laws or to discredit existing knowledge. The whole of no phenomenon is known

to man. The whole truth never can be. Ultimate truth was never in any man's possession. The unknown surrounds on all sides all knowledge in man's possession. The beginning, the end and the ramifications are beyond his reach. He was not present when the foundations of the universe were laid. He may not be present when they are destroyed. But scientific knowledge, though limited, is practical and positive so far as it goes. It rests on experiment and observation alone. Every step in observation, experiment or induction has been tested by thousands of bright minds. He is already a master in science who can suggest even one new experiment. There is nothing occult or uncanny in scientific methods. The 'magic wand' which creates new species of horses or cattle lies in the hand of any stock-breeder. The magic key of the electrician by which the foam of the cataract becomes the light of the city may be held by any municipal council. To take the illustrations given above, 'there is such a thing as a squash,' because the assumption that the squash exists constitutes a safe basis for action. On that hypothesis you can plant squashes or raise squashes or make them into pies. The brightness of the brandy-colored world we can not trust. It requires no scientific instruments of precision to record the failure of the man who guides his life on a basis of impressions made by drugs or stimulants.

"The transit of Venus is no product of fancy. To the astronomer the coming of the planet between the earth and the sun is as certain a thing as the coming of the earth into its own shadow at night. The one incident is more common than the other, but not more mysterious. And to go to that part of the earth which is turned toward the sun at the moment of transit is the simple common sense thing to do if one wishes to see the transit. The island, the abandoned hut and the cooking utensils were only incidents to the astronomer. To the natives these were the only realities and the purposes of sciences were to them unknown or absurd. To the man of common sense the digging for treasure under the direction of clairvoyants seems ridiculous. The operation does not become more wise when we see it through the eye of science. Tested by instruments of precision, 'clairvoyance' becomes a myth and such truth as its phenomena contains is explainable in simple ways.

"The spectroscope grows more real and more potent as we study its methods and results. The divining rod is only successful through ignorance or fraud. The process of weighing planets is open to all who will continue their studies till they understand it. The test of knowing is doing. The oceanic cable in the service of all who have concerns in another continent. It hides no mystery save the one eternal mystery of matter and force. The phenomena of telepathy have fled before every attempt at experiment. The study of the 'X-rays' is as far from occultism or spiritism as the manufacture of brass

is from the incarnation of mahatmas. The mind healer, the faith healer, the curative theories of 'neminism,' the sale of the patent medicine, the medical marvels of radium, the wonders of the electric belt and the power of animal magnetism are all witnesses of the potency of suggestion in the untrained mind. To the same class of phenomena the witch-hazel rod belongs. Experiment shows that its movements are the involuntary muscular contractions and that these follow simply the preconceived notions of the holder of the rod.

"If, as some one has lately said, all men sought healing from the blessed handkerchief of the lunatic or from contact with old bones or old clothes, if all physicians used 'revealed remedies' for the remedies nature suggests for each disease, if all the supposed 'natural rights' of men were recognized in legislation, the insecurity of such actions would speedily disappear. The long and bloody road of progress through fool-killing would for centuries be traversed again. Without the instruments and methods of precision which belong to science we should find ourselves in the weakness and babyhood which was the heritage of the common man through the middle ages.

"In the degree that 'organized common sense' or science, has been a factor in the lives of men and nations, men and nations have been happy and effective. The ultimate function of science is the regulation of human conduct.

"Not long since one of our sciosophical friends proposed the theory that the chemical elements were each of them forms of 'latent oxygen.' This theory he defended by the argument that the business of science was to propose all sorts of theories. As some apples on a tree will be sound so will some of these theories be true. To make every conceivable guess is the way to hit on the truth. Some such notion as this is common among cultured people of all countries. To accept it is to ignore the whole history of science. No advance in real knowledge has come from guessing, dreaming or speculating. If we want a picture taken we find a man who has a camera and who knows how to use it. If we want the truth on any subject we must find a man who has the instruments or methods of precision and who knows how to use them. There is no other way. As well expect a man without a camera and who knows not how to use it if he had one to take a photograph as to trust to a speculator, guesser or dreamer to find the truth. To work without tools, in the world of objective reality, can yield only illusion and fraud."

At the conclusion of the address, President Marvin expressed the thanks of the Astral Club for the bold and straightforward declaration of materialistic principles. But at the same time he could not refrain from reminding Mr. Grimshaw that he was still very young and that there were many things in heaven and earth and Devachan which are not yet taught in the schools.

IS MAN AN AUTOMATON?

By Professor GEORGE STUART FULLERTON
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FEW things are more irritating to the average man, who does not pretend to be a philosopher or a scientist, but respects the opinions of such, than to be told, by those whose word seems to carry authority, that he must regard himself as an automaton.

He has been accustomed to consider his own mind and the minds of his neighbors as of no little significance in the system of things. He says that he rose early, because he knew he had a long day's work before him; he took his bath, because he knew it was good for his health; he went to the dining-room, because he wanted his breakfast; he ran for the train, because he did not care to lose five minutes waiting for another; he whistled, that the conductor might hear him and might be induced to delay a moment; he climbed the stairs to his office, because the elevator seemed to be intolerably long in coming.

So it went all through the day. He did things because he wanted to, or because he thought he had to. Other men about him did things for the same reasons. His whole day seems to have been full of thoughts and feelings, plans and decisions; nor can he bring himself to believe that, had these been different, his actions and those of other men would have been what they were. So unequivocally does his experience appear to testify to all this, that it does not even occur to him to raise a question, until some professional questioner suggests a doubt.

But he spends the evening of such a day in his library, and, as he turns over the pages of certain volumes of scientific essays, his eye is caught by Professor Huxley's statement that "our mental conditions are simply the symbols in consciousness of the changes which take place automatically in the organism." If he is startled by this, his mind is by no means quieted when he turns to Professor Clifford and reads: "Thus we are to regard the body as a physical machine which goes by itself according to a physical law, that is to say, is automatic. An automaton is a thing which goes by itself when it is wound up, and we go by ourselves when we have had food."

To be sure, each of these writers softens the blow somewhat. Huxley tells us that we are *conscious* automata; and Clifford says that the body is not *merely* a machine, because consciousness goes with it. Nevertheless, this does not seem to make good the previous wrong. If

a man tells me that I am an imbecile, and then modifies the statement by adding that I am a particular kind of an imbecile, it still rankles in my breast that I am an imbecile; and I am naturally impelled to inquire into the justice of applying the title to me at all. I may not call a young lady a doll, and then soften the blow by explaining that I have somewhat extended the signification of that common word. One has a right to ask: Is the word, when so extended in meaning, rightly applied at all? Are dolls that think and speak, feel and will, and all the rest, really *dolls?* If not, why use the word, except as a figure of speech, and with insulting intent?

Now, it would be absurd to maintain that Huxley or Clifford or any other serious adherent of 'the automaton theory' has written with the intention of insulting or degrading mankind. These men had a glimpse of what they regarded as a valuable scientific truth, and they urged it upon the attention of their fellows. In doing so, however, they made use of expressions which have actually given offence to many, and have predisposed men to a rejection of their doctrine. I feel like going further and saying that the mere fact that they have seen fit to use such expressions may be taken as an indication that they have not fully grasped the significance of the truth they were endeavoring to express, but have themselves slipped into a misconception, which has harmed their cause.

I may say at the outset that I regard the cause as a good one. This does not in the least mean that I believe in any 'automaton theory.' The name is a grotesque and an offensive one, and should never have been used. The plain man is quite right in refusing to regard himself as an automaton. The real cause for which the so-called automatists, have been fighting is a clear and unambiguous conception of the relation between the mental and the physical—one which will not rub out the distinction between the two, but will do it full justice. In the present paper I shall try to show that the frank acceptance of their fundamental thesis need not make a man an automatist at all; nor need it compel him to modify the estimate which his experience has led him to form of the significance of men's actions. In other words, the man may become as 'scientific' as he pleases, without on that account being forced to repudiate common sense and common experience. Surely this is no small gain.

We all have experience of the relations which obtain between mind and body, or we should not even know that we have minds and bodies. But those who have not devoted special attention to psychology and philosophy are apt to have the vaguest of notions as to what the relations in question are. We have, to be sure, gotten beyond the crude materialism that once led men to regard the mind as consisting of five round atoms, disseminated through the body, and inhaled from the

atmosphere. But I am not sure that most persons would not be inclined to maintain that the mind is *in* the body 'somehow'—and when we inquire into the significance of this 'somehow,' we can scarcely fail to discover that it has a material flavor. Whether rightly or wrongly, most men think of the mind as in the body in somewhat—but only somewhat—the same way as material atoms may be in the body. And he who thinks of the mind in this way may, if the question occur to him at all, assume that mind and body interact *somewhat* as two material things interact with each other.

To be sure, the more one reflects upon the difference between mental phenomena and physical, the more vague and indefinite this 'somewhat' seems to become. Material things can lie beside one another in space; they can approach one another and recede from one another. Their interaction is a thing to be described in physical terms; we have to do with space and motions in space. Have we anything analogous to this when we are considering, let us say, the mental image of a railway station and those physical changes in the brain which antecede my moving my feet in the direction of the station? Is the mental image literally *in* any part of the brain? Can it approach or recede from any group of molecules? Does it mean anything to say that it lies *between* this physical occurrence and that? And if the relation between what is mental and what is physical is really so different from the relation between two physical things, must we not recognize that the word 'interaction' is ambiguous when it is applied indiscriminately to either relation?

As early as the seventeenth century reflection upon the differences which distinguished the mental and the physical led to the conclusion that it is impossible that ideas should be inserted as links in any physical chain of events. You can not plant an imaginary tree in a real ten-acre lot; you can not insert the thought of a cork into the neck of a real bottle; is it more sensible to say that the thought of a railway station may be inserted as a link in a series of changes in the nervous system of a man? To such men as Huxley and Clifford it seemed that the physical series must be regarded as unbroken. Clifford, much influenced by the philosopher Spinoza, describes the relation between physical changes in the brain and the accompanying ideas as a 'parallelism,' as a correspondence or concomitance. It is scarcely necessary to add that neither he nor any later parallelist has intended the word 'parallelism' to be taken literally. It only means that mental phenomena are to be regarded as excluded from the series of physical changes, and yet as accompanying them.

Now, I think we may leave out of consideration those who endeavor to steer a middle course—to eat their cake and, at the same time, to keep it. The question is: Is the series of physical changes to be re-

garded as unbroken, and are mental phenomena to be looked upon as the invariable concomitants of certain physical changes; or are the two classes of facts to be built into the one series? Those who accept the first alternative are *parallelists,* and those who accept the second are *interactionists.*

Naturally, there is a lively quarrel between the two sects. The parallelist insists that the interactionist has no clear notion of what he means by interaction, when he uses the word; and he maintains that, did the interactionist realize his position, he would see himself to be little better than a materialist. He has failed to recognize the great distinction between mental phenomena and physical. On the other hand, the interactionist insists that the parallelist, in declaring the series of physical changes to be unbroken, has reduced the mind to a position of utter insignificance. Every action can be accounted for by going back to its physical causes, and to those alone. The mind, then, is a mere decoration; it does nothing; the man is a physical automaton, etc., etc.

I am not going to try to persuade any one, in this paper, to become an adherent of either the one sect or the other. But it does seem rather hard that those who watch the combat should be led to suppose that, with the triumph of the one party, they are condemned to become materialists, and, with the triumph of the other, they are turned into automata. It is distressing to be confronted with Scylla and Charybdis, and to see no clear water between.

What I wish to prove is that the whole matter is one to be regarded with no other emotion than that of intellectual curiosity; and that it does not matter a particle to the plain man, from the practical point of view, which side wins.

First let us assume that the interactionist is right. Then ideas and motions in matter may be regarded as belonging to the one series—they are links in the one chain. Now, one can not piece out a defective series of sounds by the insertion of a smell; one can not, when one tree in an avenue has died, replace it by a tree in a dream. To constitute a series, in any significant sense of the word, things must have something in common; it must *mean* something to speak of gaps and insertions. Let us suppose, for the sake of argument, that it does mean something here, and that ideas are enough like motions in matter to be inserted between certain motions in matter and to form one series with them.

This may be a form of materialism; but what of that? The man whose day has been full of ideas, of desires and volitions, of plans and purposes, has had just the day that he has had; and the fact that all these are called material or semi-material does not prevent their being just what he has experienced them to be. If some material things can

be like this, and can play such an important part in his life, he should get over his repugnance to materialism, or at any rate to some sorts of materialism; and he may go on thinking and talking about himself and his neighbors much as he has thought and talked in the past. It is not worth while to be frightened by a mere word; a cold in the head is not made worse when it is given a Latin name.

It may be said, it is a waste of time to try to protect men against the fear that interactionism may be proved true, for men have no dread of this result, as it is. This I think we must admit. Those who are familiar with the history of psychology and philosophy know that there was a time when it was not repugnant to men to conceive the mind as literally a kind of matter, having its place in the body just as any other kind of matter has its place. Gradually it came to be felt that this was a misconception, and various curious attempts were made to describe the mind as immaterial. To-day nearly every one is willing to say that the mind is immaterial—the conception has become common property. Nevertheless, he who is clear-sighted can see that most men have not wholly stripped away materialistic suggestions inherited from the past; and he finds these embodied in the interactionist doctrine. As, however, interactionism does not ask the plain man to be more materialistic than he is naturally inclined to be—every one can find a comfortable seat in so roomy a place as a 'somehow'—it does not arouse his apprehensions. So I shall not spend more time in allaying fears which do not arise in most minds, but shall turn to the 'parallelist' doctrine. Its supposed terrors constitute our proper theme.

Let us suppose that the parallelist is right. Then ideas and motions in matter must be regarded as belonging to two distinct series, and they must not be made links in the one chain. Thus, a pin is thrust into my leg; I reach down to it and pull it out with my fingers. A series of changes has taken place in my body. Some message has been sent from my leg, along certain nerves, to the brain, and a message has been sent along other nerves to the muscles of my arm and hand. But this does not say everything. I have felt a pain; I have been conscious of the injury done my leg; I have wished to remove the pin; I have resolved to do so, and am conscious that I do it. The physical series is an unbroken one; the mental phenomena are concomitants of brain changes, but fill no gaps between them.

Now, if we admit all this, must we sadly accept the following doleful results?

1. Man must be regarded as an automaton.

2. Man's mind is insignificant; as his body does all that is to be done, we may say that the result would have been the same had he had no mind.

3. Hence, we ought to abandon our usual ways of thinking and speaking about ourselves and others.

If these results actually do follow from an acceptance of parallelism, men may well feel apprehensive when they see able men advocate it. If none of them follow, there is small cause for apprehension, and the question becomes one of merely scientific interest.

Let us consider the first point. Must the parallelist regard man as an automaton? No.

Before one can decide this point intelligently one must know what the word 'automaton' means. He who consults his dictionary is informed that it means 'that which is self-moving, or has the power of spontaneous movement, but is not conscious.' A little lower down it is explained to him that the term more specifically denotes 'an apparatus in which the purposely concealed power is made to imitate the voluntary or mechanical motions of living beings, such as men, horses, birds, fishes,' etc. He is further given to understand that the word may be applied to 'a person or an animal whose actions are purely involuntary or mechanical,' or to a person who acts 'without active intelligence, especially without being fully aware of what he is doing.'

Do any of these definitions cover the case of the man described in the first paragraphs of this paper? Was he without consciousness? Was he constructed to imitate the actions of a living being? Were his actions involuntary? Did he go through his day without active intelligence? Yet the definitions are very fair, and do not misrepresent the actual use of the word defined. Even in psychology, when we speak of 'automatisms,' we never have in mind a shrewdly planned raid upon the bourse, or the production of Cæsar's 'Commentaries.'

The fact that I choose to pin my faith to one view of the relation between mind and body rather than to another gives me no right to wrest words from their proper uses and to employ them in ways that must be misleading. Normal man is not an automaton in any legitimate sense of the word; and it is a grave injustice to parallelism to call it 'the automaton theory.' To be sure, Clifford and others have invited the injustice which has been visited upon them, and we can scarcely pity them as much as though it were wholly unmerited. But the frankest adherence to their parallelism need not induce us to call man an automaton. To say that consciousness is 'parallel' to brain changes is not equivalent to saying that consciousness is not present at all, or is present in defective measure.

And now for the second point. Must the parallelist regard man's mind as insignificant, and say that his actions would be the same if he had no mind? No.

Surely not. Bear in mind what parallelism maintains. It maintains that mental phenomena and certain cerebral changes are *invariable*

concomitants. This means that a given idea can not exist unless there is a certain brain-change. But it also means that the brain-change in question can not possibly exist unless the corresponding idea exists. The relation between the two is not conceived to be an accidental one. For reasons which have been indicated, the parallelist objects to calling it a causal relation, and prefers the word 'concomitance.' Nevertheless, he regards the relation as one on which we may depend absolutely—as absolutely as we can depend upon the relation between a physical cause and its effect.

But, if this is so, the plain man may perfectly well become a parallelist and yet go on talking as though certain results could not be brought about in the absence of minds. He is quite justified in maintaining that no clever book could ever be written, no such day as his has been ever lived through, by a creature without a mind. He may, if he choose, leave to the scholar by profession the question whether the word 'cause' is not somewhat loosely used in common life. What he cares about stands firm on any hypothesis: ideas *are* significant; if he can work out a satisfactory plan in his mind, desirable results will be achieved; if he has not the ideas, the results will not follow.

Now for the last point. Should the parallelist abandon our usual ways of thinking and speaking about ourselves and others? It must be admitted that the words used by some parallelists suggest, at least, that he should do so.

"An automaton is a thing that goes by itself when it is wound up, and we go by ourselves when we have had food." The suggestion certainly is that, if we want men to function, we should feed them.

It has been known, of course, from time immemorial, and in every country under heaven, that men who get no food at all will soon cease to go; and it has been known also that men who get too much drink will first go irregularly and then not at all. It is an old secret that what goes into the mouth of a man is not a matter of indifference.

But did any man, parallelist or interactionist, ever try to control the actions of his fellow man in detail by the giving of food? or try to explain why Mrs. Smith visits Mrs. Brown and neglects Mrs. Jones, by investigating the diet of that discriminating lady? We can not explain her taking the longer walk through the park rather than the shorter one along the street, by pointing out that she has legs. If she were unprovided with these members, she would undoubtedly not walk at all; but her having them does not enlighten us as to her choice of a walk, nor does it give any key to the control of her actions.

Clifford himself never tried to make men 'go' by the administration of food; he wound them up by public lectures and by printed essays, when he wanted them to think as he did and to act as he wished

them to. The truth is that the brain-changes which correspond to mental states are unknown; we have not the least conception how the brain-change of a man meditating a gift to a hospital and that of a man planning to rob a bank differ from one another. Nor have we any direct physical means of producing either. But we do know a good deal about men's minds, and we know how to arouse in them ideas which will—directly or indirectly, it does not matter which—result in definite actions.

The plain man is, then, quite right in explaining his day by a reference to ideas. We have no other way of explaining it. There is no reason for changing our usual modes of expression. The parallelist who calls himself an automatist, or who talks of winding men up by the administration of food harms his own cause gratuitously. There is nothing in parallelism, properly understood, to cause apprehension; and there is nothing about the doctrine that is startling.

It seems right that, having criticized that very clear and charming writer, Clifford, I should close with a word in his defense. It is very easy, when a doctrine is relatively new, and has not been subjected to careful criticism, to misconceive its full significance. Were Clifford alive to-day, I do not believe that he would call man an automaton at all. He would see, I think, that it is misleading to speak so. But he would still be a parallelist, and he would gain the more adherents to his interesting scientific hypothesis, in that his utterances would be less calculated to shock the common sense of his fellow men.

A VOCABULARY TEST

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I

OF all the inventions of the human race nothing compares in importance, as regards mental development, with language. In the development of each person also, nothing exercises a greater influence in molding and developing thought and feeling than his language environment. 'The vocabulary of a person represents in a condensed and symbolic form all that he has experienced and imagined. The breadth of his mental experience is indicated by the number of words that have for him a meaning, while the accuracy of his thinking is shown by the constancy and exactness of meaning with which he uses words.' The study of vocabularies ought therefore to be an important branch of psychological investigation.

Studies have been made of the number of words used by great writers, and by children a few years old. The latter studies have shown that a child may not use words that are perfectly familiar to him for months merely because he has no occasion to use them, *e. g.*, words frequently uttered in the summer or when in the country may never be used in the city or in the winter. Adults are familiar with many words that they have rarely, perhaps never, used. The difficulties in the way of counting accurately the number of words *used* by an adult or even by a child over three years of age are almost insurmountable.

When we attempt to estimate the number of words that *have a meaning* for an individual, the difficulties are less although the number of words is much greater. The writer long ago estimated the number of words in his own vocabulary by going carefully through an unabridged dictionary and counting the number of familiar words on every tenth page (see *Science*, O. S., Vol. XVIII., pp. 107–108). Since then he has often had his students estimate the number of concepts that they possessed by counting the number of words that had for them a fairly definite meaning, on a few pages of the dictionary, and then calculating from the proportion of familiar words the total number of words they knew.

When a student began, say on page 2, and counted all the words in bold-faced type and the number of these known on every fiftieth page, and then did the same beginning with page 20, the results were

so nearly the same as to convince me that the method was fairly accurate. Some preliminary tests were then made that showed that a hundred words taken by chance from various parts of the dictionary might serve as a fairly accurate measure of the size of one's understanding vocabulary. The words used in the final test consisted of fifty words taken from the first four words on every fiftieth page of Webster's academic dictionary and fifty words from the first of other pages leaving out different forms of the same root word (*e. g.*, photograph, photographer). This was done with the thought that older persons might be able to infer better the meaning of unfamiliar words than younger persons. The results were negative and the author now considers that the best list of words is obtained from Webster's academic dictionary (which contains about 28,000 words on 645 pages), by taking the first, second, or last word, or any other definite word on every sixth page. For general purposes and for all ages this is probably better than to take a hundred words from an unabridged dictionary which contains so many various and obsolete forms of the same words, along with rare words, and technical terms not found in the smaller dictionary. Estimates based on words from the academic dictionary give less than half as many words in the vocabulary as those based on data from the unabridged, but they are more representative of fundamentally different concepts.

The method of using the test was to place the printed list before the subjects and ask them to mark the words that they knew with a plus (+) sign, those that they did not know with a minus (—) sign, and doubtful ones with a question mark (?). The tests which numbered about two thousand were made chiefly upon pupils from the fourth grade up through the high school and university, although a few were made upon younger children. Control tests showed that if the same test was given orally, there was some difference in the words marked as known and unknown. This difference was of course very great in the second and third grades, where a few tests were made, and became less with age, yet it usually amounted even in the case of adults to from one to three per cent. In a few individuals the difference was quite marked.

The reason for this is that some words are more often heard than others, while others are more often seen, hence in one case the auditory stimulus arouses familiar associations while in the other case the visual stimulus is more effective. In general the auditory stimulus is more effective for children, but, as they read more, the visual stimulus becomes more effective and later many words are seen that are rarely or never heard; hence for such words the visual stimulus is the most effective and sometimes the only stimulus which will produce the reaction of familiarity. The test is more accurate if both forms of

stimuli are used, *i. e.*, the words pronounced as the pupils look at them.

There is another cause of difference and also of inaccuracy. In the auditory test unfamiliar words are often mistaken for familiar ones having a similar sound, *e. g.*, barque for bark, baron for barren, and in the visual test similarity of appearance plays a similar part. A striking case of this form of error was made by a third grade boy who marked the word amaranth as known. I said to him, 'You don't know that word, do you?' He said, 'Yes,' in a tone that implied surprise that I should question it. I then said, 'What is the word?' He replied, 'Arithmetic.' Another boy for similar reasons, partly visual and partly auditory, marked 'eschar' as known and when questioned called it 'sister.'

On the other hand, young children often do not mark words that are perfectly familiar to them, because the sounds and forms without any other stimuli of suggesting words or circumstances are not sufficient to immediately arouse the sense of familiarity. One second grade boy who marked only eighteen words in the test, when questioned, showed by synonyms or definitions, or illustrations, that he knew the meaning of thirty of the words.

Individual habits of thinking or judging is probably the largest factor in tending to make the marking of words an unreliable index of the actual mental furniture of the subject of the test. Some mark as known every word that arouses the feeling of familiarity, while others mark as known only those for which they are confident they can give a correct definition. The differences in this respect are, however, most shown in the doubtful marks while the plus mark usually means the arousal of a specific idea by the word form. This idea may be vague or distinct, narrow or broad, general or detailed, correct or incorrect, but it is the idea usually aroused by the word.

Upon defining a list of words to a class of normal students after they had marked them, it was found that the errors in marking words as known and unknown usually cancelled each other, so that the number finally reported as known and unknown was for most members of the class about the same as when they were first marked.

Instruction as to what shall be the standard for deciding whether a word is known, such as "Count as known all words that you would not, as to their meaning, need to look up in a dictionary if you saw them in a sentence," helps to render the marking more uniform. Another and more accurate method of bringing about uniformity of standard is to ask the pupils to define or put in sentences some of the words, then to mark the rest according as they think themselves able or unable to indicate their meaning.

If students are asked to define a certain proportion of the words

as accurately as possible, giving all meanings where there are more than one, depth and accuracy as well as breadth of knowledge may be tested. In college classes where twenty of the hundred words were defined, 114 out of 246 students were found to have defined the same proportion of words that they marked as known and only seventeen showed a difference of as much as three words of the twenty from the corresponding proportion of the hundred words marked. The over-estimations slightly exceeded the under estimations.

The author is convinced that one hundred words selected as has been described and marked with care gives sufficient basis for an approximate estimate of the size of the understanding vocabulary of college and high-school students, and of the higher grades of the grammar school. In the author's own classes where students were ranged in three grades according to the number of words marked as known in one list of words, other lists of words similarly selected resulted in 60 per cent. to 80 per cent. of them being again in the same grade, while none were changed from the lowest to the highest grade.

Using Webster's Academic Dictionary as a basis it appears from averaging about two thousand papers that the size of vocabularies are likely to approximate the following:

Grade II.....	4,480	Grade III.....	6,620
Grade IV.....	7,020	Grade V.....	7,860
Grade VI.....	8,700	Grade VII.....	10,660
Grade VIII.....	12,000	Grade IX.....	13,400

High School.

Freshmen.....	15,640	Sophomore.....	16,020
Junior.....	17,600	Senior.....	18,720

The average for normal school students is 19,000 and for college students 20,120. The colleges represented in this test were Bryn Mawr, Smith, Columbia, Brown University and Pratt Institute, while the grades and high schools were mostly in Massachusetts cities.

There seems to be no constant difference between the sexes. On only a part of the papers was age given, but there is reason to believe that vocabularies increase up to thirty. In Pratt Institute where students varied greatly in age, those above twenty-five knew from five to ten per cent. more words than those in the same classes who were below twenty years of age. It is not likely that the growth of vocabulary is great after thirty, when deeper specialized and executive activities have taken the place of general advancement into new fields of knowledge and many words once known are forgotten.

One important factor in the growth of vocabularies was investigated by accompanying the list of words with a request to write names of

papers and magazines frequently read and of books read since the beginning of the year. It was found that in general those who named the most books and magazines had the larger vocabularies, regardless of their grade.

The individual differences in size of vocabulary were very great, some ninth grade children falling to the rank of second grade children, while some third or fourth grade children ranked with the average of those in the ninth grade or high school.

Sometimes a very small vocabulary was accounted for by the fact that the child was of foreign parentage and did not hear English at home, but the mere fact of being of foreign parentage was no assurance that the vocabulary would be small.

II

The relation of size of vocabulary to school standing was considered, but owing to the scarcity of data and uncertainty as to its reliability (only a small proportion of the papers were accompanied by the class records or teacher's estimate of ability), no conclusive results were reached. In the grades there was no clear proof of relationship though in one room, where there was reason to think the teacher's estimate had been carefully made, the grading corresponded almost exactly to the size of the vocabularies. In one normal class nearly all of those who had been named by the faculty as belonging to the lower third of the class had small vocabularies. In another class there seemed to be little or no relation between size of vocabulary and estimates of teaching ability. In two colleges, one for women, the other for men, the marks given to the women in English and to men in all subjects were secured for the freshman class and compared with the number of words known. The average number of words known by the men who in general ranked in the various subjects above the average of their class was 5 per cent. greater than for those ranking below the average; while the women who ranked highest in English, averaged nearly 4 per cent. better in vocabularies than those who ranked lowest in English.

In the case of individuals there was often a wide divergence between the marks and the size of the vocabulary. In some instances exceptionally poor definitions indicated a difference in the standard used in marking words as known, but not always. This divergence is not, however, greater than between marks in different subjects, *e. g.*, students have honor marks in some subjects and fail to pass in others.

Is size of vocabulary any indication of attainment or ability? An affirmative answer to this can not readily be proved by experiment, because we have no reliable standard of ability and attainment by which the value of the vocabulary test may be determined. It is well known,

however, that persons who do well in one subject often do poorly in others and that success in life after school bears little relation to success in school. It has recently been shown by Dr. Thorndike that entrance examinations bear little relation to college marks.

From the side of experimental psychology, no accurate measure of intellectual ability has been established in spite of many persistent and painstaking researches. The various tests used are found to be special in their character. There are also indications that what are good tests at one age or stage of development may have no significance at another stage. Sensory and motor tests are probably valuable indications of mental ability in young children, memory and imagination tests in older children and reasoning tests in youths.

The function of the nervous system is to respond in an appropriate way to the various phases of the stimulating environment. The most common phase of environment to which human beings respond is the word environment, first to auditory words by movements, then to auditory and visual words by images and concepts. The number of words that are known by any person depends upon two factors, the variety in his word environment, auditory and visual, and his own readiness to respond to the various elements of this environment. It is perfectly natural therefore that children who are surrounded by intellectual people or who read a great deal should have large vocabularies and yet that the size of individual vocabularies should vary with their readiness to respond to this word environment. The accuracy of response or quality of knowledge can be judged not by the number of words but by the accuracy of definitions or use of words.

The question naturally arises whether size of vocabulary and ability to define and use words is not a sufficiently accurate measure of the intellectual ability of youths to justify the use of vocabulary tests in examinations for entrance to college. College work is supposed to be general in its character, demanding general ability, of which the vocabulary test ought to give an indication. Of course if students should devote their time to a special study of the dictionary, the test would become special and valueless, since size of vocabulary would not then be an accompaniment and indication of experiences and intellectual advances, but of special study of modes of defining words in terms of other word symbols.

III

A study of the kind of definitions given by persons of different ages is an interesting indication of the sources of word knowledge and of the modes of thought at different ages.

The first words are of course obtained from direct association with acts and objects and this continues to be a source of vocabulary growth.

A large proportion of words, however, come indirectly from experience through the medium of words that have already become familiar. These new words are sometimes received as equivalents of other words, because of synonyms and definitions or of special descriptions. The greater part of them, however, gain their significance from their association with familiar words in various situations, just as the original words were gained from association with various real situations.

These truths may be illustrated by the definitions of gourd given by college students. 'A drinking cup made from the gourd vine.' 'A vegetable which grows in the ground having a hard shell and many seeds.' 'A vessel for holding water or other liquid.' 'A receptacle for carrying water about, usually of skin.' 'A water bottle made from a pumpkin or squash.' 'Vessel sometimes made by scooping out, for example, making a vessel by scooping out a pumpkin.' Evidently most of these definitions represent ideas gained from sentences in which the word, 'gourd' is used, though those who speak of them as 'pumpkins' or as a 'summer squash,' may have seen the real thing without the discriminating eye of the gardener or botanist. The idea that it is a vessel of some kind evidently predominates and this idea is sufficient for interpreting most sentences in which the word occurs.

It is interesting to notice the various forms of the subordinate idea of the object itself as the various persons picture it under the stimulus of the context. 'A shell of certain nuts, fruits and vegetables, or of the cocoanut, squash, cucumber, etc.' 'In many countries it is used as a receptacle for food and drink.' 'A fruit on a tree whose shell is used for carrying water.' 'The dry fruit of some sort of tropical tree.' 'It is hard and round, and some are the size of an apple and rattle when you shake them.' 'A species of dried melon.' 'An old style wooden drinking vessel.' 'A hollow piece of cane.' 'A fruit characterized by the fibrous outer shell similar to the cocoanut.' Few of the writers of the above had a sufficiently correct idea of the article to be able to identify it if it were shown them. They react satisfactorily (to themselves) to the book situation though they would be laughed at by the gardener and botanist. It is an interesting fact that in a prominent college for women the word 'decemvirate,' which only readers of Roman history would be likely to encounter, was correctly defined by most of the young ladies, while some could give no definition for gourd, and many others gave such definitions as have been quoted. This is a striking illustration of the difference between the word environment of scholastic halls and that of the industries and the literature of to-day.

The following definitions of gourd are inexplicable until one realizes that one word form has been mistaken for another. 'To spur

on' (goad). 'To plunge a weapon into some one, to make a jagged wound' (gored). 'An animal' (goat?). 'A greedy person' (gourmand). 'A chasm or piece of land that is very much lower than the surrounding land' (gorge).

The definitions thus far quoted are by college students, and though most of them are exceptional rather than characteristic of the definitions of college students, they are surprising as well as amusing.

One English teacher was so astonished at the 'depth of ignorance' displayed by the definitions of his freshman class in English that he had all the papers looked over by his assistants, who all agreed that the results were 'shocking.' They, however, saw no relation between the definitions and the scholarship of individual pupils. (As has already been stated the figures show that those ranking high in scholarship knew on an average about 5 per cent. more words than those ranking low in scholarship.)

Character of the definitions changed greatly with age. Descriptions which are so common in the high school and college papers are rarely or never given by children in the kindergarten and primary grades. The same is true of definitions by synonyms and inclusions under larger terms. The younger children nearly always define by mention of some specific incident, *e. g.*, 'A *chair* is to sit on'; 'Baby stands up by a *chair*'; 'A *bee* goes around a piazza and makes a noise.' What anything can do, or what can be done to it, or with it, is of most importance in early knowledge of all things, hence we find the definitions of children expressing action and use more than anything else. Reference to personal experience of self and friends is also common. These facts are of great significance to pedagogy, strongly endorsing the change now being made from the old descriptive 'object lesson' to the better forms of nature study in which use is made the center of interest.

MAGICAL MEDICAL PRACTISE IN SOUTH CAROLINA

By JOHN HAWKINS

AS chemistry began in alchemy and astronomy in astrology, so medicine, to a great extent, has grown out of magic. Its first professors were sorcerers and priests; and its beginnings are to be looked for in the juggleries and mummeries of holy men and women who, by fastings, narcotics, or other means, enabled themselves to communicate with the benignant or malevolent spirits which savage philosophy finds in every object of nature. Among rude peoples the physician is often a priest and always a magician.

Alchemy is dead and astrology as it exists to-day is no longer to be considered seriously by the student of culture; but, owing perhaps to the religious factor in its origin, the science of medicine, as it is understood by a very large number of persons, is still encumbered with the dead husks of its earliest growth. Even in the most enlightened countries physicians are constantly confronted with the idea that disease is a sort of demoniacal possession which is to be relieved by prayer, or that it is some mysterious entity which can be removed only by the use of some equally mysterious remedy. Charms, medals impregnated with virtue by ecclesiastical benediction, and so-called electric and galvanic belts, pads, rings, brushes and other appliances are sold by thousands; and patent panaceas, compounded of drugs brought from strange lands or discovered in some unusual way, are bought and used by millions of credulous and afflicted persons in all parts of the world.

In view of these facts it is not remarkable that one occasionally finds in the United States, as well as in secluded nooks of the Old World, regions in which superstitious medical practises, handed down from father to son for no one knows how many hundreds of years, not only survive, but also show an astonishing degree of vitality.

Such a region occurs in the central part of South Carolina. It is a strip of country about one hundred miles long and from thirty to fifty miles wide, lying along the Santee, the Congaree, Broad and Saluda rivers, and embracing parts of the counties of Orangeburg, Lexington, Newberry and Saluda. The early European settlers of this region were Germans who came, about the middle of the eighteenth century, from the Lower Palatinate, Baden, Würtemberg and Switzerland. At a little later date small groups and isolated families of Scotch-Irish, of English and of French from the Huguenot settlements of the coast region established themselves among these peasants from the banks of the Rhine. But, broadly speaking, this part of Carolina was in the

early days a bit of Germany transplanted bodily into the new world; and, undisturbed by subsequent immigration, its inhabitants have retained to the present day many of the traits and characteristics of their ancestors. The existing surnames of the people are still largely German; the Lutheran faith is strong; the language of the fatherland has fallen into disuse almost within the memory of living men; and the customs and superstitions which prevail are, to a great extent, those bequeathed by the pioneers to their descendants.

Until ninety or a hundred years ago, according to local historians, there were no physicians in this region. Besides the stock of medical lore in the possession of the old women of every country neighborhood, the sick had recourse only to a system of practise known as 'using,' which consisted in rubbing the affected part with the hands of the operator, blowing the breath upon it, and repeating over the patient certain ancient charms or incantations, in the efficacy of which both doctor and patient had unbounded faith.

At the present day physicians are here plentiful, and in learning and skill they compare favorably with those of any country district. Many of them have enjoyed the advantages of the best schools in America, and some have studied abroad. Yet here extremes meet, and the highest and the lowest join hands. The skillful modern physician, armed with all the resources of science, sometimes finds himself face to face with a method of medical treatment as old as humanity itself; and he must pit his pills and powders against magical charms, some of which bear on their face the marks of a time when Thor and Woden were realities and not myths in the minds of men.

It must not be understood that 'using' is very generally practised. Its employment is now uncommon and exceptional. As a rule the Teutonic Carolinians are fairly intelligent, having schools, churches and newspapers, and superstition is dying out. But a stubborn conservatism, seemingly innate in human nature, makes such things die hard. There is still a class of people which clings tenaciously to the old beliefs; and this class is apt—especially when regular physicians fail, as they sometimes must, to relieve the afflicted—to have recourse to some old man or woman who enjoys a local reputation for skill in magic. Whether a cure is thus effected or not, belief in the method is not shaken, for, as Bacon remarks, men count the hits but not the misses. An occasional success offsets many failures, and so faith in the formulas which age and the authority of the elders have rendered sacred remains unimpaired.

As one star differeth from another in glory, so, too, the practitioners of 'using' differ from one another in skill and in extent of knowledge. Some are acquainted with the methods, but have little success in practise. To some who are successful only one or two of the charms are

known; others possess a half dozen or more. Skillful or unskillful, however, 'users' are by no means numerous, and when emergencies arise that demand their services it is sometimes necessary to send to considerable distances before one is found. Their scarcity is due to the fact that the formulas are jealously guarded, since the promiscuous disclosure of the secrets is thought to take away the possessor's influence over the powers which bring disease and death. The ethics of the profession demand that when an adept at 'using' feels the approach of age and death he shall divulge his magical knowledge to some one (and to one only) who is worthy to possess it; and this one is bound to transmit it in like manner to a single successor.

It is not altogether impossible, however, as this article will show, for one of the uninitiated to obtain possession of the formulas. One may sometimes find a possessor of the mystic charms who is not unwilling to communicate them to another for a money consideration. Of those grouped together below, eight were secured in this way. The remainder, with one exception, were then obtained by a system of exchange, charm being given for charm.

So much by way of preface to the formulas themselves, which are here given in italics, the directions for their use being printed in ordinary type. The authorities are followed *verbatim:*

FOR CATARACT: *I rub you with my right thumb, that you may move and depart. In the name of the Father and of the Son and of the Holy Ghost. Amen.* Rub it with the thumb from the nose outwards until you say the above words, blowing first three times. This must be done three mornings and evenings, every time three times.

FOR A FILM OVER THE EYE: *Eye, I do not know what ails you; I know not whence it is. There shall it go. In the name of the Father, the Son, and the Holy Ghost. Amen.* Rub the eye three times with the right hand and repeat three times.

FOR A BLISTER IN THE EYE: *Joseph begat Anna, Anna begat Mary, Mary begat our Lord and Saviour, Jesus Christ. This is most certainly true. Blotch, blister, go away. Do this man's* [*woman's*] *eye no harm. In the name of the Father, Son, and Holy Ghost. Amen.* Say it three times.

FOR A BURN OR SCALD: *O! you hot and burning flame, you are so hot and dark! With God, the Father, I drive you; with God, the Son, go you away. In the name of the Father, Son, and Holy Ghost. Amen.* Blow the breath three times upon the burn, pass the hand thrice over it, and say these words three times.

FOR A BURN OR SCALD: *The Holy Woman goes out over the land; what carries she in her hand? A fire-brand. Eat not in you, eat not around you. In the name of the Father, the Son, and the Holy Ghost. Amen.* Say these words three times, rub three times upward and downward, and blow three times —every time three times.

FOR INFLAMMATION: *St. John came over with all his congregation; St. Mary came over with all her communication; Christ is mighty to cure mortification and all other complaints. In the name of the Father and Son and Holy Ghost. Amen.* Say it three times.

FOR THE LIVER-GROWN: *Liver-grown and Heart-bound depart from thy ribs, as Jesus went out of the manger. In the name of God, the Father, Son, and Holy Ghost. Amen.* Dip your thumbs in fat and rub three times upon the breast and three times upon the back as you say the above words, every morning and evening for three mornings and evenings, three times. This must be done at odd hours—one, three, five, seven, nine or eleven o'clock.

FOR THE NIGHT-BRAND OR SCROFULA: *I forewarn you that you shall no longer burn, but be you cold as a dead man's hand. In the name of the Father, the Son, and the Holy Ghost. Amen.* Take the middle finger of your right hand and rub three times around as you say these words. Do this, morning and evening, three times, for three mornings and evenings.

FOR FEVER: *Jesus went over the mountain, and he saw a great fever and he cured it with his hands. In the name of God, the Father; in the name of God, the Son; in the name of God, the Holy Ghost. Amen.* Rub three times, blow three times, and repeat three times.

FOR EPILEPSY, OR FALLING SICKNESS: Take a new broom and sweep from three corners of a room. Throw the sweepings over the person who has the sickness, while you say these words: *In God's name, Falling Sickness, you must depart till I these seed do cut.* So do it three times.

FOR A WORM IN THE FINGER—WHITLOW: *As he [she] went over muddy bogger's branch he [she] met three worms; one was a white one, one was a black one, and one was a red one. I command this to die, in the name of the Father and of the Son and of the Holy Ghost. Amen.* Say it three times.

FOR STOPPING BLOOD: Say the name of the person, then: *Holy is the day and holy is the hour wherein happened the wound. In the name of the Father and of the Son and of the Holy Ghost. Amen.* Say the name of him that has the wound first; and if the wound is on the right side lay your left hand thereupon, and if on the left side lay your right hand thereupon. If you know the name of the person you may stop the bleeding though the person be three or four miles away.

FOR COLIC, OR RISING OF THE MOTHER: Lay your hand on the person's stomach and say three times: *I stand on wood and I see wood. For one glassful of cold red wine. Rising of Mother, or Colic, let this griping alone. A. B. C. May God help you. In the name of God, the Father; in the name of God, the Son; in the name of God, the Holy Ghost. Amen, Amen, and Amen.*

FOR A BOIL, OR IMPOSTHUME: *The Boil and the Dragon went over the creek. The Dragon drank, the Boil sank. In the name of the Father, Son, and Holy Ghost. Amen.* Lay your right hand upon the boil as you say these words. Do it three times, and the boil will soon decrease.

FOR THE WILD-FIRE (ERYSIPELAS): *Wild-fire, move away; the tame-fire is over you.* Take a coal of fire or a fire-brand and rub three times around it morning and evening, each time three times, as you say these words. It will soon be better.

FOR GREEDY-WORM: *When our Lord and Savior, Jesus Christ, was upon the earth he met a greedy-worm, and he said, 'Where are you going, greedy-worm? In the child's stomach or no? You shall not do that. That I forbid you, by sulphur and pitch, that I may never see you any more. Do you go in the green wood. There is a well deep and cold. Out of that well you may drink, and of this child nevermore think.' In the name of the Father, in the name of the Son, and in the name of the Holy Ghost. Amen, Amen, and Amen.* Blow your breath three times on the face and say these words three times over.

FOR OPEN HEAD: *Head, I squeeze you together for [name of patient]. In the name of the Father, Son, and Holy Ghost.* Press together three times each way and say these words three times.

A CURE FOR BOTS:

There was a man
Rode over the land
With three worms in his hand.
One was white, another black, the other red,
And in an hour they were dead.

Stand the horse with his head toward sunrise. Take your right hand and rub from the nose over the head, neck, and back, down to the end of the tail, as you say these words. Do this three times in two or three hours, every time three times. Give some purgative medicine.

There are two more formulas which, though not strictly medical in character, are so nearly akin to those already given that they may be

appropriately included in the same list. One of them is used when the first collar is placed upon a colt's neck, and it is supposed to prevent the equine vice known as 'balking,' and to cause the animal to work satisfactorily. It is as follows:

Refuse not to pull while the Jews keep Saturday for Sunday. In the name of the Father, the Son, and the Holy Ghost. Amen.

The other is used to prevent the depredations of thieves and burglars and the approach of deadly enemies. If one has a house or a field which he wishes to protect he should walk around it three times, repeating the incantation each time. It is thought that any one attempting to cross the line thus made will be paralyzed, in his tracks, and will have to stand there until released by the sorcerer. This must be done before sunrise; otherwise the offender may die. The charm is as follows:

When Mary lay in child-bed and Joseph was about to flee away, Joseph cried out and said: 'There goes a thief in our house who wants to steal the child.' And Mary said: 'St. Peter bade, St. Peter said, "I have bound him in God's hand." Whosoever would, in twenty-three hours, steal from me or do any hurt to my life shall stand there till I tell him to go away.' In the name of the Father, the Son, and the Holy Ghost. Amen.

About seventy years ago the writer's grandfather removed his family from South Carolina to the west, and on the eve of his departure a neighbor gave him this charm for the protection of the wagon-camp at night, but its virtue was never tested. In South Carolina it seems still to be used, and there are two or three recent stories of watermelon thieves having been caught in this way. One relates that at daybreak the thief was seen standing, unable to move or even to drop the bag of stolen melons on his shoulder.

There are also formulas for the cure of cancer and for the removal of warts, but these the writer has not been fortunate enough to secure. A very old lady of his acquaintance, Mrs. R—, from whom some of the formulas mentioned were obtained, says that she was cured of cancer many years ago by one Adam Boland, of Newberry County, who was a famous 'user' in his day. In her case the 'using' was done when she was not present. She says that Boland, after repeating the charm and the name of the patient three times, always took an axe and cut into the heart of a pine tree in order to ascertain whether the treatment would prove successful. If the tree lived the patient would recover; otherwise, the charm was powerless. Mrs. R— gives some further particulars of interest. Her daughter learned a few of the formulas when a child and used them frequently and successfully to relieve her father's illness, although he had no faith in the practise. The charms lose their force if taught by a younger person to an older one; the learner should always be younger than the teacher. The point of view from which many persons look on these superstitious methods of treatment is well illustrated by a remark of Mrs. R—. She says:

I don't see why 'using' shouldn't be as efficient as prayer, since the three highest names [Father, Son, and Holy Ghost] are always used. At any rate it can do no harm, if it does no good; and in this respect it differs from the drugs used by physicians.

If we look for practises analogous to these mentioned here the abundance of material is found to be overwhelming. The use of charms and incantations for the cure of disease may be noted in all ages since the dawn of history and among peoples of all grades of culture. Pepys gives several, current in his day, which are very similar in character to those given above; for example, the following, for stopping blood:

Sanguis mane in te
Sicut Christus fuit in se;
Sanguis mane in tua vena
Sicut Christus in sua pœna;
Sanguis mane fixus
Sicut Christus quando fuit crucifixus.

He also gives one for a burn which is almost identical with one of those now in use in South Carolina:

There came three angels out of the East;
The one brought fire, the other brought frost.
Out, fire; in, frost.
In the name of the Father, Son, and
Holy Ghost. Amen.

Reginald Scot in 'The Discoverie of Witchcraft,' published in 1584, records an accredited method:

To heale the King's or Queen's evill, or any other sorenesse of the throte: Let a virgine, fasting, laie hir hand on the sore and saie: *Apollo denieth that the heate of the plague can increase where a naked virgine quencheth it, and spet three times upon it.*

This is interesting as showing the survival of a formula dating from pre-Christian times. There is very good reason for believing that the incantations of the 'users' of the present day may claim an equal antiquity. Like some of the festivals of the church, they had their origin in heathen times, and the introduction of Christianity did not suffice to shake their hold on the popular mind. In old Germany neither Charlemagne's conquest nor the priest who followed it could put a period to the use of staves carved with mystic runes and devoted to the purposes of divination and incantation. The oak, the ash and the willow preserved their sacred character; and in the old heathen formulas for the cure of disease, the only change effected by Christianity was the substitution of the 'three highest names' (Father, Son and Holy Ghost) for those of Thor, Woden and other heathen deities. The following heathen and Christian versions of a popular charm for sprains will illustrate the change effected:

OLD VERSION.

Phol and Woden
went to the wood;
there was of Balder's colt
his foot wrenched;

then Sinthgunt charmed it,
and Sunna her sister;
then Frua charmed it,
and Volla her sister;
then Woden charmed it,
as he well could,
as well the bone-wrench,
as the joint-wrench,
as the blood-wrench;
bone to bone,
blood to blood,
joint to joint,
as if they were glued together.

CHRISTIANIZED VERSION.

Our Lord rade,
His foal's foot slade;
Down he lighted,
His foal's foot righted;
Bone to bone,
Sinew to sinew,
Flesh to flesh.
Heal, in the name of the Father,
the Son, and the Holy Ghost. Amen.

Examples of similar formulas might be multiplied indefinitely from all parts of the world, and from the remotest times to the present, but this is unnecessary. It is enough to note the curious fact that if the practise of the Carolina 'users' of the present day could be witnessed by Egyptian physicians of four thousand years ago, by Druid priests from the Gaul described by Cæsar, and by American Indian medicine men from the time of Columbus, it would appear to all of them a perfectly natural and philosophical method of treatment, however unintelligible the language of the formulas might be.

Besides the superstitions already cited, there exists in this region a number of other magical healing practises. These, however, unlike 'using,' can not be said to belong exclusively to that part of the population which is descended from the early German settlers. Africa is certainly the native land of some of them. The others form a part of that vast body of popular lore, of mixed and uncertain origin, which is the common property of the people of northern and western Europe and their descendants.

A prescription for rheumatism is closely allied to some of the 'using' practises, although no words are to be repeated over the patient. It is compounded of a teacupful of sweet cream, thickened with salt, seven buds of brier, nine of rosemary and eleven grains of black pepper. When these have been allowed to simmer together the mixture is to be skimmed, and with the remaining ointment the rheumatic parts are to be rubbed 'downward and outward on three Fridays in the dark of the moon.' Simpler remedies for rheumatism are rattle-snake oil; grease fried from toads; and a sharp knife or razor taken to bed with the patient to 'cut the pains.'

To cure cramp it is only necessary to wear garters of eel-skin, or to invert the sufferer's shoes under his bed at night. Herpes, or shingles, should be rubbed with blood from a black cat's tail or from a black fowl's neck. Treatment should be prompt, as it is thought that the patient will certainly die if the inflammation completely encircles the body.

Negroes seem especially subject to inflammation of the uvula, an ailment known among them as 'falling palate.' In Orangeburg County the favorite treatment consists in pressing the uvula upward with the back of a silver spoon, at the same time pulling strongly at a tuft of hair on the top of the head. Many negroes cultivate a tuft of hair, for this purpose, over the middle of the forehead. In another mode of treatment the uvula is supposed to be driven up into its proper place by smart blows administered with a stick upon the soles of the feet.

Warts and corns are everywhere the object of many superstitious practises. In South Carolina the owner of these excrescences may take his choice of several remedies. He may select a broom straw having as many joints as there are warts to be removed, pick the warts until they bleed, and put a drop of blood from each wart upon a joint of the culm, then bury the straw under the eaves of the house. Or he may count the warts and tie in a string the same number of knots, and bury the string. Another method is to rub each wart with a pea, and bury the peas in the same way. Still another is as follows: Tie as many knots in a string as there are warts to be removed; blindfold the patient and lead him about until he is lost; then give him the string, which he should bury in the ground, unobserved by any one. As the string decays the warts will disappear. Corns may be removed by rubbing them with a grain of corn and then feeding the grain to the oldest fowl in the yard. This last remedy comes from a very old negro woman, still living, who was brought from Africa in her childhood; but this may not mean that the remedy is African in origin.

An old lady, whose parents were Scotch-Irish, gives the following remedy for bleeding of the nose: Let the nose bleed on three pieces of cloth, put these in three holes bored into as many different kinds of fruit-bearing trees, and stop the holes. This will result in a permanent cure. A gruesome drink for epilepsy is a tea made of a piece of rope with which some one has been hanged. Equally repulsive is a reputed remedy for chills and fever, consisting of pills made of dried and pulverized earthworms. Risings and boils may be cured by the touch of one who has crushed a ground-mole to death in his hands.

Either from the great number of ailments to which they are subject or from their helplessness, or possibly from both causes combined, infants claim a large share of magical medical practise. When a baby is born an axe is sometimes placed under the mother's couch with the

blade upward to cut the 'after-pains' of childbirth. To render teething easy and painless the infant's gums are rubbed with a 'cooter' bone, the ear or bone of a rabbit, or the warm brains of the same animal just killed. It is thought that nine live wood-lice tied in a bag and suspended from the neck of a child having thrush will soon give relief. The touch of a posthumous son is recommended for the same complaint. As a preventive of croup a black silk thread or a string of 'electric' (amber) beads is placed around the neck.

In the little city of Newberry a few years ago an infant was supposed to have been cured of a disease known as 'stretches' by passing it through a horse-collar warm from use. Some authorities say that shoe-sole tea should first be administered, to be followed by the horse-collar treatment. In the same county an infant who had a case of umbilical hernia was passed by his father through a cleft in a living young white-oak tree. The theory was that the child would recover if the tree lived; if it died the hernia would remain. The tree and the patient, both of them living and whole, are still here to convince unbelievers of the virtues of magical medicine.

The passing of children through rings of various kinds is comparatively common. One of the 'using' formulas already given in this article is for the cure of 'liver-grown,' an ailment known also as 'growed-on' and 'grow-fast,' in which the liver is supposed to adhere abnormally to some other organ. This is also treated by passing the patient through a horse-collar or between the rungs of a ladder. In still another method the afflicted infant is passed between the legs of a table, after which it is held by the feet and tossed upwards towards each of the four corners of the room, care being taken, however, to prevent it from falling or from striking the walls. In Newberry County, several years ago, a negro mother, misunderstanding the directions given her by an old woman for this treatment, killed her child by throwing it forcibly against the four corners of her log house.

It is not always easy to explain the philosophy of superstition, but in these cases the thought underlying the treatment is sufficiently evident. The idea seems to be that disease is caused by an evil spirit which may be misled and puzzled by mazes of rings and tortuous passages. Thus, interlaced cords are still sold in Italy as charms, and Persian carpets are woven in intricate patterns to bewilder the evil eye.

Analogies to the Carolina practises cited are abundant and they lead us back to very remote times. Mr. Edward Clodd, the English author of several works on custom, myth and religion, is authority for the statement that the practise of drawing infants through the cleft trunks of trees (usually ash) still prevails in remote rural districts of England. Scotch witches in effecting magical cures used to pass their patients nine times through rings or garlands of woodbine; and from

Scotland comes also the custom of passing young chicks through the orbits of a horse's skull to keep the hawks from catching them. The perforated monoliths of Great Britain and northern Europe are known generally as 'Odin Stones,' probably because, according to the Norse mythology, Odin in the shape of a worm bored his head through a stone to get at the 'mead of poetry'; and babies have been drawn through them from ancient times to cure them of various ailments. These monoliths, as well as the small perforated 'Odin' stones still used as amulets in the same countries, are closely related to the salagrama, or holy stone, common, curiously enough, to Italy and India. In Italy the salagrama is a stalagmite which is believed, on account of its resemblance to the mounds thrown up by earthworms, to be such a mound petrified. The people carry it in a bag with some magical herbs, and repeat over it an incantation which recites that its cavities and irregularities are potent to bewilder the evil eye. The Indian salagrama is a kind of ammonite about as large as an orange and having a hole through it. A legend relates that Vishnu, the Preserver, when pursued by the Destroyer, was changed by Maya into the stone, through which as a worm the Destroyer bored his way. It is believed that the evil eye is blunted by the perforation and by the irregularities of the stone's surface.

The survival in the midst of a high civilization of these Carolina practises, allied as they are to practises and beliefs of almost primitive times, affords a pertinent illustration of the manner in which magical arts cling to life. We have seen how heathen charms and incantations not only failed to disappear before the coming of Christianity, but even gained a new lease of life by hastening to enlist themselves under its banner. It is the same way with superstitions in general. Adapting themselves from age to age to the changed conditions which surround them, here receding and there advancing, dying out only to reappear under changed and scarcely recognizable forms, they yield almost imperceptibly to the advance of sound learning and common sense. Their retreat, however, has been more rapid since science has begun to shed her rays into the dark places where such things hide themselves; and in proportion as this great light becomes more generally diffused magic in medicine, as in all other departments of human thought, will fade and finally disappear.

THE VALUE OF SCIENCE

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Chapter V. Analysis and Physics

I

YOU have doubtless often been asked of what good are mathematics and whether these delicate constructions entirely mind-made are not artificial and born of our caprice.

Among those who put this question I should make a distinction; practical people ask of us only the means of money-making. These merit no reply; rather would it be proper to ask of them what is the good of accumulating so much wealth and whether, to get time to acquire it, art and science are to be neglected, which alone should make us capable of enjoying it, 'and for life's sake to sacrifice all reasons for living.'

Besides, a science made solely in view of applications is impossible; truths are fecund only if bound together. If we devote ourselves solely to those truths whence we expect an immediate result, the intermediary links are wanting and there will no longer be a chain.

The men most disdainful of theory get from it, without suspecting it, their daily bread; deprived of this food, progress would quickly cease, and we should soon congeal into the immobility of China.

But enough of uncompromising practicians! Besides these, there are those who are only interested in nature and who ask us if we can enable them to know it better.

To answer these, we have only to show them the two monuments already rough-hewn, Celestial Mechanics and Mathematical Physics.

They would doubtless concede that these structures are well worth the trouble they have cost us. But this is not enough. Mathematics have a triple aim. They must furnish an instrument for the study of nature. But that is not all: they have a philosophic aim and, I dare maintain, an esthetic aim. They must aid the philosopher to fathom the notions of number, of space, of time. And above all their adepts find therein delights analogous to those given by painting and music. They admire the delicate harmony of numbers and forms; they marvel when a new discovery opens to them an unexpected perspective; and has not the joy they thus feel the esthetic character, even though the senses take no part therein? Only a privileged few are called to enjoy it fully, it is true, but is not this the case for all the noblest arts?

This is why I do not hesitate to say that mathematics deserve to be cultivated for their own sake, and that the theories inapplicable to physics should be so as well as the others. Even if the physical aim and the esthetic aim were not united, we ought not to sacrifice either.

But more: these two aims are inseparable and the best means of attaining one is to aim at the other, or at least never to lose sight of it. This is what I am about to try to demonstrate in setting forth the nature of the relations between the pure science and its applications.

The mathematician should not be for the physicist a mere purveyor of formulas; there should be between them a more intimate collaboration. Mathematical physics and pure analysis are not merely adjacent powers, maintaining good neighborly relations; they mutually interpenetrate and their spirit is the same. This will be better understood when I have shown what physics gets from mathematics and what mathematics, in return, borrows from physics.

II

The physicist can not ask of the analyst to reveal to him a new truth; the latter could at most only aid him to foresee it. It is a long time since one still dreamt of forestalling experiment, or of constructing the entire world on certain premature hypotheses. Since all those constructions in which one yet took a naive delight it is an age, to-day only their ruins remain.

All laws are therefore deduced from experiment; but to enunciate them, a special language is needful; ordinary language is too poor, it is besides too vague, to express relations so delicate, so rich, and so precise.

This therefore is one reason why the physicist can not do without mathematics; it furnishes him the only language he can speak. And a well-made language is no indifferent thing; not to go beyond physics, the unknown man who invented the word *heat* devoted many generations to error. Heat has been treated as a substance, simply because it was designated by a substantive, and it has been thought indestructible.

On the other hand, he who invented the word *electricity* had the unmerited good fortune to implicitly endow physics with a *new* law, that of the conservation of electricity, which, by a pure chance, has been found exact, at least until now.

Well, to continue the simile, the writers who embellish a language, who treat it as an object of art, make of it at the same time a more supple instrument, more apt for rendering shades of thought.

We understand, then, how the analyst, who pursues a purely esthetic aim, helps create, just by that, a language more fit to satisfy the physicist.

But this is not all: law springs from experiment, but not immedi-

ately. Experiment is individual, the law deduced from it is general; experiment is only approximate, the law is precise, or at least pretends to be. Experiment is made under conditions always complex, the enunciation of the law eliminates these complications. This is what is called 'correcting the systematic errors.'

In a word, to get the law from experiment, it is necessary to generalize; this is a necessity imposed upon the most circumspect observer. But how generalize? Every particular truth may evidently be extended in an infinity of ways. Among these thousand routes opening before us, it is necessary to make a choice, at least provisional; in this choice, what shall guide us?

It can only be analogy. But how vague is this word! Primitive man knew only crude analogies, those which strike the senses, those of colors or of sounds. He never would have dreamt of likening light to radiant heat.

What has taught us to know the true, profound analogies, those the eyes do not see but reason divines?

It is the mathematical spirit, which disdains matter to cling only to pure form. This it is which has taught us to give the same name to things differing only in material, to call by the same name, for instance, the multiplication of quaternions and that of whole numbers.

If quaternions, of which I have just spoken, had not been so promptly utilized by the English physicists, many persons would doubtless see in them only a useless fancy, and yet, in teaching us to liken what appearances separate, they would have already rendered us more apt to penetrate the secrets of nature.

Such are the services the physicist should expect of analysis; but for this science to be able to render them, it must be cultivated in the broadest fashion without immediate expectation of utility—the mathematician must have worked as artist.

What we ask of him is to help us to see, to discern our way in the labyrinth which opens before us. Now, he sees best who stands highest. Examples abound, and I limit myself to the most striking.

The first will show us how to change the language suffices to reveal generalizations not before suspected.

When Newton's law has been substituted for Kepler's, we still know only elliptic motion. Now, in so far as concerns this motion, the two laws differ only in form; we pass from one to the other by a simple differentiation. And yet from Newton's law may be deduced by an immediate generalization all the effects of perturbations and the whole of celestial mechanics. If, on the other hand, Kepler's enunciation had been retained, no one would ever have regarded the orbits of the perturbed plants, those complicated curves of which no one has ever written the equation, as the natural generalizations of the ellipse. The

progress of observations would only have served to create belief in chaos.

The second example is equally deserving of consideration.

When Maxwell began his work, the laws of electro-dynamics admitted up to his time accounted for all the known facts. It was not a new experiment which came to invalidate them. But in looking at them under a new bias, Maxwell saw that the equations became more symmetrical when a term was added, and besides, this term was too small to produce effects appreciable with the old methods.

You know that Maxwell's *a priori* views awaited for twenty years an experimental confirmation; or if you prefer, Maxwell was twenty years ahead of experiment. How was this triumph obtained?

It was because Maxwell was profoundly steeped in the sense of mathematical symmetry; would he have been so, if others before him had not studied this symmetry for its own beauty?

It was because Maxwell was accustomed to 'think in vectors,' and yet it was through the theory of imaginaries (neomonics) that vectors were introduced into analysis. And those who invented imaginaries hardly suspected the advantage which would be obtained from them for the study of the real world; of this the name given them is proof sufficient.

In a word, Maxwell was perhaps not an able analyst, but this ability would have been for him only a useless and bothersome baggage. On the other hand, he had in the highest degree the intimate sense of mathematical analogies. Therefore it is that he made good mathematical physics.

Maxwell's example teaches us still another thing.

How should the equations of mathematical physics be treated? Should we simply deduce all the consequences, and regard them as intangible realities? Far from it; what they should teach us above all is what can and what should be changed. It is thus that we get from them something useful.

The third example goes to show us how we may perceive mathematical analogies between phenomena which have physically no relation either apparent or real, so that the laws of one of these phenomena aid us to divine those of the other.

The very same equation, that of Laplace, is met in the theory of Newtonian attraction, in that of the motion of liquids, in that of the electric potential, in that of magnetism, in that of the propagation of heat and in still many others. What is the result? These theories seem images copied one from the other; they are mutually illuminating, borrowing their language from each other; ask electricians if they do not felicitate themselves on having invented the phrase flow of force, suggested by hydrodynamics and the theory of heat.

Thus mathematical analogies not only may make us foresee physical analogies, but besides do not cease to be useful when these latter fail.

To sum up, the aim of mathematical physics is not only to facilitate for the physicist the numerical calculation of certain constants or the integration of certain differential equations. It is besides, it is above all, to reveal to him the hidden harmony of things in making him see them in a new way.

Of all the parts of analysis, the most elevated, the purest, so to speak, will be the most fruitful in the hands of those who know how to use them.

III

Let us now see what analysis owes to physics.

It would be necessary to have completely forgotten the history of science not to remember that the desire to understand nature has had on the development of mathematics the most constant and happiest influence.

In the first place the physicist sets us problems whose solution he expects of us. But in proposing them to us, he has largely paid us in advance for the service we shall render him, if we solve them.

If I may be allowed to continue my comparison with the fine arts, the pure mathematician who should forget the existence of the exterior world would be like a painter who knew how to harmoniously combine colors and forms, but who lacked models. His creative power would soon be exhausted.

The combinations which numbers and symbols may form are an infinite multitude. In this multitude how shall we choose those which are worthy to fix our attention? Shall we let ourselves be guided solely by our caprice? This caprice, which itself would besides soon tire, would doubtless carry us very far apart and we should quickly cease to understand each other.

But this is only the smaller side of the question. Physics will doubtless prevent our straying, but it will also preserve us from a danger much more formidable; it will prevent our ceaselessly going around in the same circle.

History proves that physics has not only forced us to choose among problems which came in a crowd; it has imposed upon us such as we should without it never have dreamed of. However varied may be the imagination of man, nature is still a thousand times richer. To follow her we must take ways we have neglected, and these paths lead us often to summits whence we discover new countries. What could be more useful!

It is with mathematical symbols as with physical realities; it is in comparing the different aspects of things that we are able to compre-

hend their inner harmony, which alone is beautiful and consequently worthy of our efforts.

The first example I shall cite is so old we are tempted to forget it; it is nevertheless the most important of all.

The sole natural object of mathematical thought is the whole number. It is the external world which has imposed the continuum upon us, which we doubtless have invented, but which it has forced us to invent. Without it there would be no infinitesimal analysis; all mathematical science would reduce itself to arithmetic or to the theory of substitutions.

On the contrary, we have devoted to the study of the continuum almost all our time and all our strength. Who will regret it; who will think that this time and this strength have been wasted? Analysis unfolds before us infinite perspectives that arithmetic never suspects; it shows us at a glance a majestic assemblage whose array is simple and symmetric; on the contrary, in the theory of numbers, where reigns the unforeseen, the view is, so to speak, arrested at every step.

Doubtless it will be said that outside of the whole number there is no rigor, and consequently no mathematical truth; that the whole number hides everywhere, and that we must strive to render transparent the screens which cloak it, even if to do so we must resign ourselves to interminable repetitions. Let us not be such purists and let us be grateful to the continuum, which, if *all* springs from the whole number, was alone capable of making *so much* proceed therefrom.

Need I also recall that M. Hermite obtained a surprising advantage from the introduction of continuous variables into the theory of numbers? Thus the whole number's own domain is itself invaded, and this invasion has established order where disorder reigned.

See what we owe to the continuum and consequently to physical nature.

Fourier's series is a precious instrument of which analysis makes continual use, it is by this means that it has been able to represent discontinuous functions; Fourier invented it to solve a problem of physics relative to the propagation of heat. If this problem had not come up naturally, we should never have dared to give discontinuity its rights; we should still long have regarded continuous functions as the only true functions.

The notion of function has been thereby considerably extended and has received from some logician-analysts an unforeseen development. These analysts have thus adventured into regions where reigns the purest abstraction and have gone as far away as possible from the real world. Yet it is a problem of physics which has furnished them the occasion.

After Fourier's series, other analogous series have entered the do-

main of analysis; they have entered by the same door; they have been imagined in view of applications.

The theory of partial differential equations of the second order has an analogous history. It has been developed chiefly by and for physics. But it may take many forms, because such an equation does not suffice to determine the unknown function, it is necessary to adjoin to it complementary conditions which are called conditions at the limits; whence many different problems.

If the analysts had abandoned themselves to their natural tendencies, they would never have known but one, that which Madame Kovalevski has treated in her celebrated memoir. But there are a multitude of others which they would have ignored. Each of the theories of physics, that of electricity, that of heat, presents us these equations under a new aspect. It may therefore be said that without these theories we should not know partial differential equations.

It is needless to multiply examples. I have given enough to be able to conclude: when physicists ask of us the solution of a problem, it is not a duty-service they impose upon us, it is on the contrary we who owe them thanks.

IV

But this is not all; physics not only gives us the occasion to solve problems; it aids us to find the means thereto, and that in two ways. It makes us foresee the solution; it suggests arguments to us.

I have spoken above of Laplace's equation which is met in a multitude of diverse physical theories. It is found again in geometry, in the theory of conformal representation and in pure analysis, in that of imaginaries.

In this way, in the study of functions of complex variables, the analyst, alongside of the geometric image, which is his usual instrument, finds many physical images which he may make use of with the same success. Thanks to these images he can see at a glance what pure deduction would show him only successively. He masses thus the separate elements of the solution, and by a sort of intuition divines before being able to demonstrate.

To divine before demonstrating! Need I recall that thus have been made all the important discoveries? How many are the truths that physical analogies permit us to present and that we are not in condition to establish by rigorous reasoning!

For example, mathematical physics introduces a great number of developments in series. No one doubts that these developments converge; but the mathematical certitude is lacking. These are so many conquests assured for the investigators who shall come after us.

On the other hand, physics furnishes us not alone solutions; it furnishes us besides, in a certain measure, arguments. It will suffice

to recall how Felix Klein, in a question relative to Riemann surfaces, has had recourse to the properties of electric currents.

It is true, the arguments of this species are not rigorous, in the sense the analyst attaches to this word. And here a question arises: How can a demonstration not sufficiently rigorous for the analyst suffice for the physicist? It seems there can not be two rigors, that rigor is or is not, and that, where it is not there can not be deduction.

This apparent paradox will be better understood by recalling under what conditions number is applied to natural phenomena. Whence come in general the difficulties encountered in seeking rigor? We strike them almost always in seeking to establish that some quantity tends to some limit, or that some function is continuous, or that it has a derivative.

Now the numbers the physicist measures by experiment are never known except approximately; and besides, any function always differs as little as you choose from a discontinuous function, and at the same time it differs as little as you choose from a continuous function. The physicist may, therefore, at will suppose that the function studied is continuous, or that it is discontinuous; that it has or has not a derivative; and may do so without fear of ever being contradicted, either by present experience or by any future experiment. We see that with such liberty he makes sport of difficulties which stop the analyst. He may always reason as if all the functions which occur in his calculations were entire polynomials.

Thus the sketch which suffices for physics is not the deduction which analysis requires. It does not follow thence that one can not aid in finding the other. So many physical sketches have already been transformed into rigorous demonstrations that to-day this transformation is easy. There would be plenty of examples did I not fear in citing them to tire the reader.

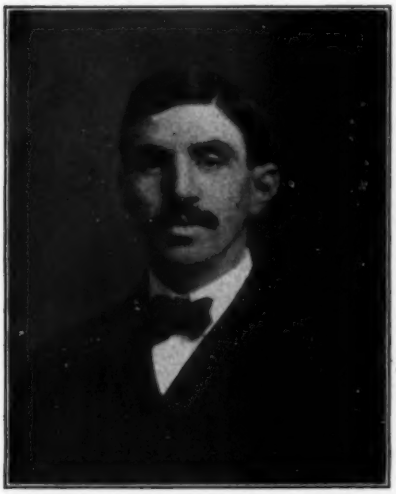
I hope I have said enough to show that pure analysis and mathematical physics may serve one another without making any sacrifice one to the other, and that each of these two sciences should rejoice in all which elevates its associate.

THE PROGRESS OF SCIENCE

THE CONVOCATION WEEK MEETINGS

THE meetings of the American Association for the Advancement of Science and of the twenty-one national scientific societies affiliated with it, held in New York City from December 26 to January 2, exhibited convincingly the great progress that has taken place in this country in scientific research and in scientific organization. Twenty years ago Brown Goode, who was better informed than any other in regard to the history of science in America, estimated that our scientific men numbered about five hundred. There were about 2,500 scientific men at the New York meeting and about 800 scientific papers were presented before the sections of the association and the special societies. The growth of our scientific institutions and the increase in the number of our scientific men appear to be in a geometric ratio. There are now at least 5,000 scientific men in the United States, and it is by no means impossible that twenty years hence the number will be 50,000. And this is but as it should be. There are 100,000 physicians and 500,000 teachers in the country, and one half of the physicians and one tenth of the teachers might to advantage engage in scientific research. The nation can certainly afford to devote one tenth of its resources and one tenth of its people to ideal ends, and in the case of science the conditions are favorable also on the economic side, for the more we give to science the more we receive from it.

It seems almost impossible to select from the hundreds of scientific addresses, papers and discussions any for special mention. Some people are disappointed because no great discovery is announced at such a meeting. As a



EDWARD KASNER, Professor of Mathematics in Columbia University, Vice-president for the Section of Mathematics and Astronomy.

CLIFFORD RICHARDSON, Director of the New York Testing Laboratories, Vice-president for the Section of Chemistry.

Jessie Tarbox Beals, photographer.

WELD. FISHER. LANE. HOBBS. MCNAIR. WARD.
BENJAMIN. HOWARD. R. S. WOODWARD. SUMMERS. CONKLIN. OSBORN.
TRELEASE. MCGEE. RICE. C. M. WOODWARD. WELCH. CATTELL. HAZEN. MACDOUGAL. HAYFORD.

SOME MEMBERS OF THE COUNCIL OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

ALFRED C. LANE, State Geologist of Michigan, Vice-president for the Section of Geology and Geography.

matter of fact, the great discoveries in the history of science are but few, and it is as a rule only in retrospect that they are seen in their true perspective. The doctrine of the origin of species by natural selection is probably one of the two great scientific advances of the past century, and it was clearly and dramatically announced at a certain meeting of the Linnean Society. Yet no one would expect the newspapers the next morning to devote their front pages to a report of the meeting. The work of the scientific men of the country during the year was more important for the people than the proceedings of its congress and legislatures, and this work was in large measure reported at the New York meeting. Almost any one of the researches presented might be the subject of an interesting article; abstracts of all of them, so brief as to be unintelligible, would fill a volume of the MONTHLY.

The first article of the constitution of the American Association reads as follows: "The objects of the Association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give a stronger and more general impulse and more systematic direction to scientific research, and to procure for the labors of scientific men increased facilities and a wider usefulness." Certainly a meeting such as that of the present year does much to advance these objects. The council of the association, to which the affiliated societies now elect delegates, is a body truly representative of scientific research and of scientific men. Its functions in the future will probably become more important than hitherto, for it is not only able to conduct the business of the association, but to exert a predominant influence on the conditions which affect scientific progress.

The retiring president of the Association, Professor Calvin M. Woodward, known both as an engineer and for his

EDWIN G. CONKLIN, Professor of Zoology in the University of Pennsylvania, Vice-president for the Section of Zoology.

Jessie Tarbox Beals, photographer.

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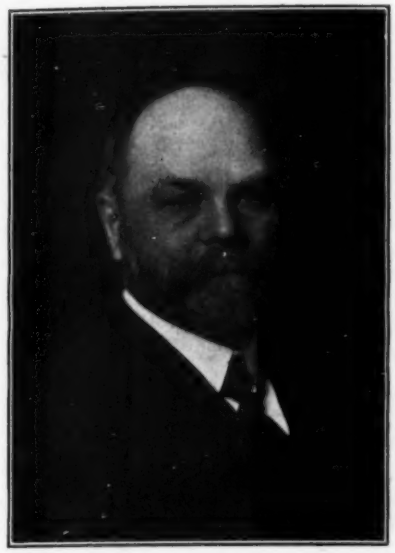
DINNER OF THE AMERICAN SOCIETY OF NATURALISTS.

1. Dr. Charles B. Davenport, President of the Society. 2. Professor J. Playfair McMurrich, president-elect. 3. Professor D. P. Penhallow, vice-president. 4. Professor E. L. Thorndike, secretary. 5. Dr. William H. Welch, president of the American Association. 6. Dr. L. O. Howard, secretary of the Association.

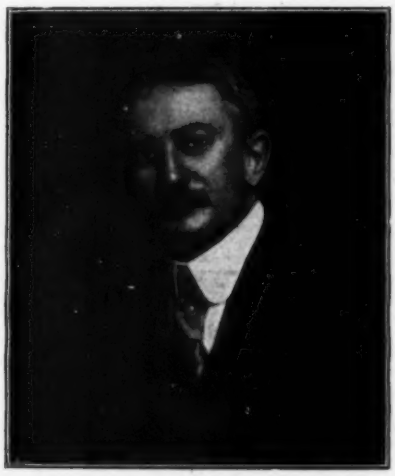


W. R. WARNER, President of the Warner and Swasey Company, Vice-president of the Section for Mechanical Science and Engineering.

leadership in introducing manual training in the schools, chose as the subject of his address 'The Science of Education,' and one of the most important transactions of the association was the establishment of a section of education. A similar section of the British Association, established several years ago, has proved to be of much value, and there is reason to believe that this section, which begins auspiciously with Dr. Elmer E. Brown, U. S. commissioner of education, as chairman, will accomplish much for the advancement of education as a science, for the teaching of science in the schools and colleges and for the improvement of educational administration in our schools, colleges and universities.

The section last established was one for physiology and experimental medicine, which at the present meeting

SIMON FLEXNER, Director of the Laboratories of the Rockefeller Institute for Medical Research, Vice-president for the Section of Physiology and Experimental Medicine.



CHARLES A. CONANT, Treasurer of the Morton Trust Company, Vice president for the Section for Social and Economic Science.

cooperated with the national societies devoted to physiology, anatomy, bacteriology and psychology, and held a special session for the discussion of 'Protozoa as Factors in the Diseases of Animals and Plants.' It is also noteworthy that for the first time, at least in recent years, a representative of the medical sciences was president of the association, thus giving recognition to the fact that medicine

has now taken its place among the sciences. To this result perhaps no one in this country has contributed so much as Dr. W. H. Welch, of the Johns Hopkins University, who presided over the New York meeting. He is succeeded in the presidency by Dr. E. L. Nichols, of Cornell University, who is eminent for his contributions to experimental physics and has at the same time exerted a great influence on educational development and scientific organization. The standard set by the presidency of the association is well maintained by the vice-presidents for the sections, who are as follows: Mathematics and Astronomy, Professor E. O. Lovett, Princeton University; Physics, Professor Dayton C. Miller, Case School of Applied Science; Chemistry, Professor H. P. Talbot, Massachusetts Institute of Technology; Mechanical Science and Engineering, Professor Olin H. Landreth, Union College; Geology and Geography, Professor J. P. Iddings, University of Chicago; Zoology, Professor E. B. Wilson, Columbia University; Botany, Professor C. E. Bessey, University of Nebraska; Anthropology, Professor Franz Boas, Columbia University; Economics and Social Science, Dr. John Franklin Crowell, New York City; Physiology and Experimental Medicine, Dr. Ludvig Hektoen, University of Chicago; Education, Dr. Elmer E. Brown, U. S. Commissioner of Education. The meeting next year will be held at Chicago, where, as throughout Illinois and the adjacent states, science has in recent years begun to rival the earlier development on the Atlantic seaboard.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

THE first report of the president to the trustees of the Carnegie Foundation gives Mr. Carnegie's original letter, the certificate of incorporation in New York, the act of incorporation by the congress, the by-laws of the corporation, the report of the treasurer, and the rules for granting retiring allowances, as well as an account of what has been accomplished and a discussion of policy by President Pritchett. As has already been announced, the pensions are of two kinds, one given at or after the age of sixty-five to men who have been professors for fifteen years, and one given after twenty-five years of service. The pensions are relatively larger for those having small salaries, being arranged on a sliding scale of from nine tenths to one half the salary. The foundation may give a pension to the widow of a professor entitled to a retiring allowance, and has given pensions to disabled professors, though there is no clear provision covering the latter case.

There are certain accepted institutions, at present fifty-two in number, whose professors receive the pensions automatically on application from the institution, and the foundation may award pensions to professors of other institutions. On October 1, there had been awarded forty-five allowances to professors in accepted institutions, thirty-five allowances to individual professors and eight allowances to widows. The average allowance to the first class is $1,552; to the second $1,302, and to the third $833. Denominational institutions are excluded by the act of incorporation; the inclusion of institutions supported by the state is under advisement.

The report gives the accompanying summary of the salaries of the professors in American colleges. There is also included a history of the pensions of professors and a discussion of standards of admission to universities and colleges.

Mr. Carnegie's great benefaction will aid our universities, colleges and technical schools, and will thus of course be welcomed by their professors. Whether it will, as President Butler of Columbia University says in his annual report, 'lift one of the heaviest

Class of Institutions.	No. of Institutions.	Total No. Professors.	Total Amount Salaries.	Average No. in Faculty.	Average Pay-roll in Institution.	Average Pay of a Professor.
Denominational.....	218	2,802	$3,305,930	13	$15,165	$1,180
State Institutions.....	58	1,461	2,617,210	25	45,120	1,787
Non-Denominational.	51	1,944	3,708,220	38	72,710	1,907
	327	6,207	$9,631,360			

burdens that they have had to bear' 'from the shoulders of hundreds of hard-working and ill-compensated men' is more problematical. These hard-working and ill-compensated professors are not so badly off after all, and if their salaries have not increased in proportion to the greater cost and higher standards of living, they should themselves see to it that justice is done. Harvard, Yale, Columbia, Cornell and other universities already had pension systems as a matter of contract with their professors, and if it is intended that Mr. Carnegie's foundation shall be of benefit to the professors, their salaries should be increased by the amount of income set free. It is quite possible that professors will in the end be paid just so much the less, because pensions have been assured to them. The individual professor would probably have gained more and certain institutions would have gained less if the trustees had been professors instead of presidents.

President Pritchett says in his report: "It is evident to the trustees that, to better the profession of the teacher and to attract into it increasing numbers of strong men, it is necessary that the retiring allowance should come as a matter of right, not as a charity. No ambitious and independent professor wishes to find himself in the position of accepting a charity or a favor, and the retiring allowance system simply as a charity has little to commend it." But unfortunately the pensions of widows and for disablement are at present on a charity basis. They should either be abandoned, or made so that they will accrue as a matter of contract. In the German universities a professor receives his salary for life. He may cease lecturing if disabled by illness or old age, but he may continue to lecture as long as he sees fit to such students as care to hear him. In case of death a pension is provided for his widow and for each child. This is more satisfactory than the system proposed by the Carnegie Foundation. However, it might not be possible to adjust it to the American college. Certainly all professors and all scientific men should be sincerely grateful to Mr. Carnegie. But it is a misfortune that he did not make professors trustees of the Carnegie Foundation and scientific men trustees of the Carnegie Institution.

THE SAND-DUNES OF THE DESERT OF ISLAY

It is a familiar fact that sand-dunes are carried along by the winds. Much labor and expense have been incurred in many localities, especially near the sea, to prevent the damage which their movement inflicts on the neighboring country. These sand-hills are found in great numbers in nearly all the desert regions of the earth, and their forms and motions have been described by different writers. A recent volume of the *Annals* of the Harvard Observatory contains a somewhat elaborate discussion of the crescent-shaped sand-dunes of the Desert of Islay in Peru, by Professor S. I. Bailey, who observed them during eight years.

The coast region of Peru is desert throughout its whole extent. In some places it is made up of barren hills, in others, of arid plains. The Pampa, or Desert of Islay, is bounded by the

Andes, the Pacific, and the rivers Vitor and Tambo. Its length and breadth are about equal, perhaps fifty miles in extent. The mean elevation of the pampa is about four thousand feet, increasing toward the north. It is a great plain with occasional low hills, almost devoid of animal and vegetable life, except among the low hills facing the sea. It appears to have been formerly the bed of the ocean. The surface is composed of sand, sprinkled over with stones and small boulders, and an occasional outcrop of rock.

A SAND-DUNE on the Desert of Islay.

Scattered over the pampa, especially in its northern portion, are hundreds of crescent-shaped sand-dunes. Their form is always the same, approximately that of the new moon, unless some unusual object is encountered by the dunes in their journey across the desert. Their motion seems to be always toward the north or northwest, in the same direction as that of the prevailing south and southeast wind. The convex surface is directed toward the wind, and the cusps lie in the direction of motion. Their size varies between rather wide limits. They are in general from one hundred to two hundred feet broad, and from ten to twenty feet high. They are composed entirely of a fine gray sand, and are moved along by the wind so perfectly that not only is the crescent form preserved, but none of the sand is left behind to mark the passage. A casual glance at the surface of the pampa detects little if any of the sand which enters into the composition of the dunes. The same variety of sand is found, however, by digging beneath the surface. It appears that all the available surface sand has already been collected by the wind into these symmetrical heaps, and that, unless the surface is disturbed by some convulsion of nature, the dunes may all finally disappear among the hills on the north of the desert. This theory seems to be confirmed by the abundance of dunes in the northern part of

the desert, and their absence from the southern part. The motion is always to the north but varies somewhat with the season and the strength of the wind. Tables and curves are given in the discussion, showing the relations between the rate of motion and the wind. Only the comparatively strong winds are able to move the sand. During the year 1900 the wind was recorded stronger than ten miles per hour 1,477 times, of which the wind was southerly 1,414 times, and in all other directions only 63 times. The strongest winds are always southerly, reaching at times 20 miles per hour. Northerly winds are not strong and persistent enough to break up the symmetrical form of the dunes. The following brief table gives the mean monthly motion of the dunes:

Month.	Movement. Feet per Month.	Movement. Inches per Day.
January.....	5.6	2.2
February.....	7.1	3.0
March.....	6.0	2.3
April.....	3.4	1.3
May	2.7	1.1
June.....	3.2	1.3
July	3.0	1.2
August.....	3.9	1.5
September.....	5.9	2.4
October.....	6.6	2.5
November.....	8 0	3.2
December	5.9	2.3

The crescent shape is well preserved as the dune advances, except where the force or direction of the wind is affected by some adjacent object. The sand-dunes are formed in different parts of the desert, and move across it till they reach the hills on the northern border. These low hills are the burial places of the dunes. As individuals they go to pieces as soon as they touch these irregular formations, and become merely confused heaps of sand. Assuming the average journey, which they travel, to be twenty-five miles, since the mean yearly motion is about sixty-one feet, the life of a sand-dune may be estimated at more than 2,000 years. Since the desert is somewhat broken in places by ravines and low hills, it is probable that but few of them make the full journey without at some time losing their identity.

SCIENTIFIC ITEMS

THE national scientific societies which met in New York City during convocation week elected presiding officers as follows: The American Society of Naturalists, Professor J. Playfair McMurrich, University of Michigan; The Astronomical and Astrophysical Society of America, Professor E. C. Pickering, Harvard College Observatory; The American Mathematical Society, Professor H. S. White, Vassar College; The American Physical Society, Professor E. L. Nichols, Cornell University; The American Chemical Society, Professor T. Marston Bogert, Columbia University; The Association of American Geographers, Professor Angelo Heilprin, Yale University; The American Physiological Society, Professor W. H. Howell, The Johns Hopkins University; The Society of Vertebrate Paleontologists, Professor Bashford Dean, Columbia University, The American Entomological Society, Professor J. H. Comstock, Cornell University; The American Botanical Society, Professor George F. Atkinson, Cornell University; The American Psychological Association, Dr. Henry Rutgers Marshall, New York City; The American Philosophical Association, Professor H. N. Gardiner, Smith College; The American Anthropological Society, Professor Franz Boas, Columbia University.

DR. WILLIAM H. WELCH, Dr. Henry S. Pritchett and the Hon. William H. Taft have been elected trustees of the Carnegie Institution.

THE Brazilian government proposes to establish a national geological survey under the direction of Dr. O. A. Derby, who was for many years geologist of the state of S. Paulo. Dr. Derby went to Brazil in 1875, as a

member of the extinct commissão geologica, of which Professor C. F. Hartt was the chief. He has lived in Brazil ever since, and is the leading authority on Brazilian geology.—Professor J. A. Bownocker, of the State University, has been appointed state geologist of Ohio to succeed Professor Edward Orton, Jr., resigned.—The lords commissioners of the admirality have appointed Syndey S. Hough, Esq., F.R.S., chief assistant to the astronomer at the observatory, Cape of Good Hope, to be astronomer at that observatory on the retirement of Sir David Gill, K.C.B.

Dr. William A. Noyes, head of the department of chemistry in the Bureau of Standards, and secretary and editor of the American Chemical Society, has been elected professor of chemistry in the University of Illinois.—Professor Ernest Rutherford, Macdonald professor of physics in McGill University, has been appointed to succeed Professor Schuster as Langworthy professor and director of the physical laboratories at the University of Manchester.—Dr. William Duane, professor of physics in the University of Colorado, at Boulder, has resigned to accept a position in the Curie Radium Laboratory at Paris. The fund providing for Dr. Duane's work is the gift of Mr. Andrew Carnegie.

At the annual banquet of the National Geographic Society the first award of its gold medal was made to Commander Peary.—Professor T. W. Richards has been elected an honorary member of the Royal Institution of Great Britain.—Mr. Alexander Agassiz has chartered the steam yacht *Virginia* for a cruise to the West Indies. The yacht will sail from New York the first week in February to be absent for three months.

Mr. John D. Rockefeller has given the University of Chicago $2,700,000 for its permanent endowment, and $217,000 for current expenses and special purposes. It is further reported that Mr. Rockefeller will give $3,000,000 for a pension at the University of Chicago, and $2,000,000 for the proposed Louisville University.